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REGISTERED AS A NEWSPAPER.

Royal Society for the Encouragement of Arts, Manufactures, and Commerce.

The Royal Society of Arts was founded in 1754, and incorporated by Royal Charter in 1847, for the Encouragement of the Arts, Manufactures, and Commerce of the country

At present the Society numbers about 4,000 Fellows. The annual subscription is Three Guineas, the life subscription Thirty Guineas. There is no entrance fee.

Fellows are entitled to be present at all meetings of the Society. These include the Ordinary Meetings, held every Wednesday during the Session, when papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed; the Meetings of the Indian and Colonial Sections, at which subjects connected with our Indian Empire and the Colonies and dependencies are considered, and the various lectures on technical subjects delivered under the Cantor and other trusts. Fellows also receive a weekly copy of the *Journal* which contains full reports of the Society's proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce; and they are entitled to the use of the library and reading room.

Proposal forms and further particulars relating to the work of the Society, may be obtained from the Secretary, Mr. G. K. Menzies, at the Society's House, John Street, Adelphi, London, W.C. (2).

Gen. Soc. Ex.

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3809. VOL. LXXIV.

FRIDAY, NOVEMBER 20th, 1925.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

ONE-HUNDRED-AND-SEVENTY-SECOND SESSION, 1925-1926.

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 23rd, at 8 p.m. (Cantor Lecture.) R. LESSING, Ph.D., F.C.S., M.I.Chem.E., "Coal Ash and Clean Coal." (Lecture I.)

TUESDAY, NOVEMBER 24th, at 4.30 p.m. (Dominions and Colonies Section.) MRS. JULIA W. HENSHAW, F.R.G.S., C. de G., Director of National Parks Association, Canada, "The National Parks of Canada." (Dr. Mann Lecture.) THE RT. HON. LORD BLEDISLOE, K.B.E., will preside. (The lecture will be illustrated by lantern slides painted by the author.) Tea and coffee will be served in the Library at 4 p.m.

WEDNESDAY, NOVEMBER 25th, at 8 p.m. (Ordinary Meeting.) DAVID GREENHILL, Director and General Manager, Sun Engraving Company, Ltd., "Colour Printing." SIR ERNEST HODDER-WILLIAMS, C.V.O., will preside. (Exhibits showing recent developments in Colour Printing will be on view.)

COUNCIL.

A meeting of the COUNCIL was held on MONDAY, NOVEMBER 9th. PRESENT:—Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Frank Baines, C.V.O., C.B.E.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Captain Sir Acton Blake, K.C.M.G. K.C.V.O.; Sir William Henry Davison, K.B.E., D.L., M.P.; Sir Archibald Denny, Bt., LL.D.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Sir Edward A. Gait, K.C.S.I., C.I.E.; Sir Robert Abbott Hadfield, Bt., D.Sc., F.R.S.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Sir George Sutton, Bt.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas; Professor J. M. Thomson, F.R.S.; and Dr. J. Augustus Voelcker, M.A., Ph.D., with Mr. G. K. Menzies, M.A. (Secretary of the Society).

The question of decorating the rear wall of the Society's House, facing the Strand, was considered. A further announcement will be made at an early date.

The serious illness of Mr. George Davenport, Chief Clerk, who has been in the Society's service for fifty-three years, was reported, and certain re-arrangements of the clerical staff were authorised.

Sir Alfred Ewing, K.C.B., F.R.S., Principal of the University of Edinburgh, was appointed to deliver the William Sturgeon Lecture in 1926.

Papers offered for reading at the Society's meeting were considered.

Certain additions were made to the Dominions and Colonies Section Committee.

Other financial and formal business was transacted.

SECOND ORDINARY MEETING.

WEDNESDAY, NOVEMBER 11th, 1925. THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., in the chair.

The following candidates were proposed for election as Fellows of the Society :—

Brenner, William H., Matillas, Spain.
Goss, Edward O., Waterbury, Conn., U.S.A.
Hanna, J. C. D., Bacup, Lancs.
Johnston-Noad, Edward, London.
Kichlu, B. B. L., Multan, India.
Scharnberg, Herman J. B., Oriente, Cuba, West Indies.

The Trueman Wood Lecture on "The Modern Note in Industrial Art," was delivered by SIR CECIL HARCOURT-SMITH, C.V.O., LL.D., late Director and Secretary, Victoria and Albert Museum.

The lecture will be published in the *Journal* of November 27th.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

WEDNESDAY, NOVEMBER 4TH, 1925.

SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., LL.D., D.Sc., F.R.S., Chairman of the Council, in the Chair.

The Chairman delivered the following address :—

THE ORGANISATION OF SCIENTIFIC RESEARCH THROUGHOUT THE EMPIRE.

INTRODUCTION.

I do not intend to discuss the value of research in science, either in its bearing on general culture or in its more direct application to commercial industries. These were appreciated by many before the war and more widely, if still but vaguely, as the result of our shortcomings during the painful years which followed 1914.

The Prime Minister, in a recent speech in the House of Commons on unemployment, condensed a widely accepted view in the following words :—

> "No one will assert that British industry can be saved by science alone, but it is none the less true that until scientific methods and scientific men can take their place in industry, and an equal place with the administrator and the financier, British trade will never be strong enough or resilient enough to meet the shocks that it is bound to meet as the years go by, or to meet the sudden and unexpected changes which will always arise in international trade."

It is the problem of organising research institutions, rather than the value of research itself that I have been urged to discuss in this address, and the problem falls into two natural divisions that are intimately related; firstly, the evolution of a system of concerted action in Great Britain, and, secondly, the linking up of activities here with those in the Empire overseas.

Mr. Baldwin referred to the importance of applied science as an essential constituent of our economic armoury under peace conditions. We have had very painful illustrations of our industrial shortcomings during the war, but there is a phase of this question that has been less discussed, namely, the importance of making each large section of the Empire self-contained, not merely as an ordnance store, but as a manufacturing arsenal for essential munitions. The partial isolation of India and Australia during the last war gave us some idea of what will probably follow the greater development in the near future of submarine and aerial machines of war. We have also learnt three other matters of vital importance:—First, that nine-tenths of the articles and materials required by a modern army in the field closely resemble those that are essential to the maintenance of ordinary civil activities; second, that the manufacture of all of them are problems of applied science; and, third, that often the interval between the laboratory and the workshop cannot be closed except by years of organised and expensive experiment on a large scale. The experimental work required for the commercial production of synthetic indigo cost over a million sterling and twenty years of hard work.

Organisation on a national and even on an imperial basis is necessary, not merely to prevent unnecessary overlap of effort, of which, unfortunately, there has never hitherto been much danger, but to close the vulnerable gaps in our economic, and, therefore, military, defence works. There is no institution or society in this country before which questions of this sort can be more appropriately discussed; for no single voluntary society has done more than the Royal Society of Arts to extend the interest in science applied to industry; and the illustrations that I intend to refer to in the sequel will show you that I am not indulging in even an approach to complimentary encouragement.

If I attempted to describe the many organisations that have been successful in stimulating the research work of specialists who are scattered throughout the Empire, the Secretary of the Society would find it difficult to get this address into a single "part" of the *Journal*; if I referred even briefly to the failures, the Treasurer would refuse to pass our printers' bill. I propose to confine myself to a few illustrations to show in what directions co-operation can best meet the requirements of an Empire so widely scattered geographically; so different in climatic and commercial conditions, and so varied in forms of administration and government.

Those who have made attempts to design and construct the machinery

of correlation have had more things to consider than geographical and climatic diversity, or the rapid specialisation and remarkable growth in bulk of the sciences. Planning to meet these complexities might be relatively easy if human nature were uniform and British science workers always docile. The main problem has been to give the local worker freedom in research activities, and yet at the same time get him to realise his obligations to the rest of the Imperial team.

VOLUNTARY SOCIETIES.

All movements in this country having for their object the correlation of activities in scientific research were, until the end of the last century, purely voluntary. "The Royall Society of London for improving Naturall Knowledge," which is still the recognised leader, commenced its corporate life on the 15th July, 1662, and grew out of a small body, who, on the 5th December, 1660, made an agreement "to meete together weekely to consult and debate concerning the promoting of Experimental learning," each paying "one shilling towards the defraying of occasional charges."

SOCIETY OF ARTS.

The Royal Society in its earliest days included papers on technical and industrial subjects, as well as papers on pure science; but its recognition of the applied side of science became insufficient to meet the demands which accompanied the industrial revolution and commercial expansion of the 18th century. The Society of Arts was consequently founded in 1754, and has, during the subsequent 171 years, maintained its position, without restriction of scope, as a voluntary association of those interested in turning the results of science in all its branches to account for the "encouragement of Arts, Manufactures and Commerce."

The curve showing the Society's expansion has occasionally steepened beyond its average slope, but has only once seriously sagged, and that was immediately preceding a period of rapid growth which was genetically connected with the evolution of our existing system for correlating research activities throughout the Empire. This period of remarkable activity was during the two decades following 1843, when the Prince Consort accepted the office of President, and took an active interest in the work of the Council until his death in 1861.

Two movements which were then originated by the Society have done more than any other instances of the sort that I can recall to stimulate national consciousness to the value of applied science, and both of these occurred in 1851—the Great Exhibition and the union of so-called mechanics' institutes, with its accompanying system of uniform examinations.

The success of the system of provincial examinations led to imitations, or rather specialised developments, which in their own way have been equally useful in stimulating the study of applied science, namely, those

afterwards instituted by the Science and Art Department and those commenced in 1879 and still conducted in technology by the City and Guilds Institute. The old Science and Arts Department served its purpose and gave way to other systems; and the City and Guilds Institute has extended its influence to overseas parts of the Empire and now examines some 8,000 students annually.

In the control of examinations the Society, as in other activities, adopted the policy of standing aside in favour of each specialised organisation. That it has been wise in thus curtailing its programme for the benefit of others, is shown by the later history of its examinations. Sir Henry Trueman Wood* expressed satisfaction that the numbers of our examinees rose from under 10,000 in 1900 to nearly 30,000 in 1913. It must be some satisfaction to him to know that his successor's burdens are not lightened; for the examinees have since increased in numbers annually, and last year reached the heavy total of over 70,000.

I feel tempted almost, at this point, to break away from the subject which has been suggested to me by friends as the theme for this address, and to show you by many like illustrations how the Society has grown in size and value, whilst encouraging the multiplication of its family of specialists by fission from the old parent. Neglect of the spirit which actuated our predecessors in this way has often in other non-specialised institutions been a drag on efforts made to effect a better organisation of scientific research in the Empire; but "that is another story."

The other outstanding enterprise which this Society, under the influence of the Prince Consort, undertook proved to be equally fruitful in useful bye-products. Immediately following, and almost directly as a result of, the Great Exhibition of 1851 there arose "The Government School of Mines and of Science applied to the Arts," and this in 1863 became the Royal School of Mines, the oldest of the three institutions which were afterwards federated to form the Imperial College of Science and Technology.

Out of these two special enterprises on the part of the Society there thus arose the movement towards scientific and technical education leading to research, at first national and then imperial in its scope. It is interesting to notice that this last development, which required the shock of the war for us to take up seriously, resembles in a marked degree the very earliest activities of the Society. At its first meeting on the 22nd March, 1754, the Society decided to offer a prize for the growth of madder to displace the article then imported largely from the East and the Low Countries, and from that time onwards the *Transactions* record about an equal division of the Society's revenue between awards for inventions at home and agricultural work in the Colonies. The North American Colonies occupied most attention until their secession in 1774—attempts to encourage the production of silk, wine,

* A History of the Royal Society of Arts (John Murray) 1913, pp. 427 and 434.

potash, iron, hemp, pickled sturgeon, myrtle wax and wooden pipe-staves followed, in order, until the old records remind one almost of the Bulletins of the Imperial Institute. Then followed the attempt to transplant the bread-fruit from the Pacific Islands to the West Indies, resulting first in the Mutiny of the *Bounty*, but followed by Captain Bligh's success in 1793. Bread-fruit, because of the notorious *Bounty*, happens to be the one best known, but was only one of many—some successful and some otherwise—cinnamon, opium, indigo, cotton, camphor, quinine, tinctorial plants, and ornamental woods. Similar efforts were made to assist the development of the East Indies, Ceylon, Canada, the Cape and Australia. The office of the Society was for many years the principal channel of information between isolated workers in the Colonies and the scientific men and merchants at home.

I have referred to the two main phases of the Society's effort to turn science to account in industries of imperial as well as of national importance, because it is a striking instance of a characteristically British institution, maintained at the expense of its members for the benefit of the country and without the slightest financial assistance from Government. In 1856 the House of Lords called for a return of the sums of money granted by Government to the Society during the preceding five years. The answer then was *nil*, and so the subject was allowed to drop. That answer applies still.

National Institutions.

Efforts by private individuals were made early in the present century to make the country conscious of its dangers, but the results of such efforts were limited and fragmentary. The Imperial Institute, which was founded in 1887 to commemorate the jubilee of Queen Victoria's reign, was reconstituted in 1902 and transferred to Government in the hope that it would be able to assist more efficiently in the development of the natural resources of the Empire overseas. The National Physical Laboratory was established at Teddington under the control of the Royal Society in 1902, and its subsequent career of success, in which Sir Richard Glazebrook was the leading spirit, has justified the object of its foundation ; it has since expanded considerably, although the public money granted for its maintenance is still less than one-tenth of that devoted to its nearest American equivalent, the Bureau of Standards at Washington. The Imperial College of Science and Technology received its Royal Charter in 1907, and was founded " to give the highest specialised instruction and to provide the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry."

These are examples of the sporadic efforts which show that Government, even before the war, considered it necessary to develop national institutions for scientific research ; they even showed the dawning of an imperial spirit ;

but it required the war, and with it the serious danger of imperial disintegration, to bring home to us fully three convictions: firstly, that our inability to manufacture many essential munitions was due to the neglect of applied science in peace time; secondly, that isolated instances of private enterprise must necessarily leave many gaps of vital importance in the programme of scientific work, and, thirdly, that some system of wider co-ordination was necessary to give effect to any political measures of a fiscal nature required to make the Empire relatively self-contained.

Research Department.

Ideas, however, developed quickly when the winter campaign of 1914-15 proved that the war was no ordinary military campaign, but was a competition to death of science and technology in an intensive form. Early in May, 1915, the principal scientific societies, with the Royal Society at their head, urged on Government the importance of tackling our difficulties, and in June of that year the President of the Board of Education announced the decision of Government to establish a permanent organisation for the promotion of industrial and scientific research, "which would operate over the kingdom as a whole and utilise the most effective means to the end in view irrespective of their locality. Since science and industry were both indifferent to political boundaries a single fund for the good of the United Kingdom as a whole was entrusted to a single authority —a Special Committee of the Privy Council," which was to work through an Advisory Council of distinguished scientific men.

The Advisory Council were directed to frame a programme for their own guidance in recommending proposals for research and for the guidance of the Committee of Council in allocating such State funds as might be available. According to the Order in Council, it was realised that the scheme would naturally be designed to operate over some years in advance, and in framing it the Council would necessarily have due regard to the relative urgency of the problems requiring solution, the supply of trained researchers available for particular pieces of research, and the material facilities in the form of laboratories and equipment which were available or could be provided for specific researches. Such a scheme would naturally be elastic and require modification from year to year; but it was obviously undesirable that the Council should live "from hand to mouth" or work on the principle of "first come first served," and the recommendations should thus represent progressive instalments of a considered programme and policy.

The new Advisory Council decided to give science in its application to industry precedence over pure science in their deliberations. They found that certain researches which were conducted by professional associations in the period preceding the war were in danger of abandonment, and they decided to assist these by special grants. They conferred with the specialised

associations, societies and institutions of science and technology, and formed a register of the researches which were being conducted in educational institutions on the outbreak of war, and they attempted to facilitate the resumption of these by financial assistance and by recovering when possible specialists who were with the new army in the field. They formed special Committees for various branches of applied science, in order to get the best advice regarding the investment of public funds and the necessity of new enterprises.

It is impossible in a short address to describe or even to enumerate the various activities of the new Department of Scientific and Industrial Research which thus started in 1915 and continues still, with the help of its Advisory Council, to carry on a work of co-ordination, which, if instituted before the war, would have saved many lives and have reduced our consequent financial burden.

What the Department has done and is doing is set out plainly in its Annual Reports; they show that at last we have the machinery which will prevent unnecessary overlap as well as the far more important matter of closing up, as fast and as thoroughly as practicable, the dangerous gaps in our development of applied science. What was before an amorphous mob of scientific workers is now approaching the form of an organised army, without, however, inhibiting that freedom and individuality which is essential to every research worker; and the Department does not attempt to do itself what can quite well be done in established colleges, universities and other institutions. This phase of its policy has an important bearing on the question which I propose to discuss in the sequel.

There is abundant room still for expansion, and there are opportunities for spending economically far more than the annual half-million that the Department now disburses; but the progress of research to be healthy is limited by various difficulties that will take time to remove. Among other things, research workers are not manufactured by mass production. Only a fraction of those who get a scientific education are suitable, and even these cannot now be absorbed readily by firms who are suffering from the general depression of our technical industries.

Overseas Organisations.

The institution of the new Commitee of the Privy Council on the 28th July, 1915, was quickly followed by a suggestion that the scheme intended for the United Kingdom should be extended and made applicable to the Dominions and even to the Empire as a whole. The proposal in definite form came from Australia; where it originated with a memorandum by the Public Works Minister of Victoria. The Committee of the Privy Council here backed the suggestion by a memorandum which might be read advantageously to Parliament every time it assembles. Its appreciation

of the value of applied science when the sky was overcast with war clouds reminds one of Kipling's contrast between the respect we show Tommy Atkins in peace time and what we think of him "when the drums begin to roll."

The Committee pointed out how the Australian suggestion could be turned to practical account, with the establishment in each Dominion of an authoritative body like that established at home; they showed how an organisation of the sort would react on the educational work of the universities in which the research workers are mainly trained, and they indicated the necessity of having in London some sort of clearing house and information bureau.

The Dominions and India promptly set up central authorities corresponding approximately to the new Committee at home, and the evolution of these is summarised in the Annual Reports of the Department. It is not necessary to repeat the details in this address, but, as the result of the correspondence and of later Imperial Conferences, various developments of great importance followed. In the first place, instead of having in London a general Bureau of Information, it was considered desirable to establish specialised Bureaux by Imperial co-operation, and various subjects were considered to be suitable, such as agriculture, statistics, mycology, and minerals. For entomology an organisation existed before the war and its obvious success encouraged the hope that the idea was capable of extension. Before the reaction of peace and the subsequent economic depression affected Government as well as commercial firms, separate Imperial Bureaux had already been started for Minerals and Mycology, and these deserve more than a passing notice; for they justify the belief that the system might be extended to other branches at a cost that forms a very small fraction of their value, to overseas workers especially.

Civil Research Committee.

The Research Councils and corresponding central authorities under other names in India and the Dominions underwent changes after the cessation of war, and the developments which have occurred form very interesting object-lessons for students of administration. Before speaking of these, of the Imperial Resources Bureaux in London and of other attempts to build and furnish the superstructure, I should like very briefly to refer to the way in which the Government at home have very recently attempted to complete the framework. This latest decision shows, at any rate, that the seed which was sown in 1915 did not actually die during the post-war financial drought.

In the House of Lords on the 20th May last, Lord Balfour announced the intention to form a sort of super-committee, the Committee of Civil Research, analogous in principle and functions to the Committee of Imperial Defence, and, like it, to be an Advisory Body with no administrative and executive functions. This Committee, over which the Prime Minister

will preside, will be charged with the duty of giving connected forethought from a central Imperial standpoint to the development of economic, scientific and statistical research in relation to civil policy and administration. It will also indicate new areas in which enquiry might profitably be undertaken.

On the analogy of the Committee of Imperial Defence, this new Committee will not be constant in composition, but may include, as and when required, specialists both private and official. It will deliberate on questions that cannot by themselves be dealt with by any single administrative department of Government, and it will thus form a responsible and authoritative medium of correlation in a way that would not be possible for any junior or voluntary association. There are many branches of science outside the scope of the new Research Department, which was formed mainly to supervise the activities in those branches that before touched many departments independently.

I have now dealt in outline with the general scheme of organisation—its origin, its foundation and the framework of its superstructure. It is important to inspect more closely samples of the infilling. The most important of these are :—

(1) The Imperial Information Bureaux in London ;

(2) The Trades Research Associations, and especially the largest of them, the Empire Cotton Growing Corporation ;

(3) The Research Councils, or corresponding authorities, in India and the Dominions ; and

(4) The specialised Institutes, here and overseas.

IMPERIAL BUREAUX.

As I have said, special Imperial Bureaux were set up in London before the financial depression, which followed the war, induced the Dominions to halt. So far as they have gone, it seems fair to conclude that they promise to justify the cost of their permanent maintenance, and to indicate the desirability of re-considering other subjects. We might consider in order those devoted respectively to entomology, mycology and minerals.

ENTOMOLOGY.

Anyone who has lived in a tropical country will be able to appreciate, as a consequence of painful personal experience, the importance as well as the magnitude of measures intended to stamp out noxious pests or to encourage friendly insects. Among the special branches of science of economic value to an Empire with large possessions within and near the tropical belt, I should regard entomology as perhaps first in importance. A few illustrations of each sort should be sufficient to illustrate the damage as well as the benefactions due to insects.

It is only because of their want of information about the devastation caused by insects that those responsible for the administration of agricultural and

horticultural countries limit their expenditure on entomological services. In America, where these services are most developed, we are able to obtain figures which show that the cost of employing entomologists is negligible when compared with the losses that might be avoided. The losses in 1921 due to the cotton boll weevil in the United States amounted to some 40 million sterling, and in the same year in Egypt the pink boll-worm caused damage to the cotton crop estimated at a total of about 10 millions. One could multiply examples of this sort.*

The blood-sucking insects known as tsetse-flies have almost depopulated large areas in Africa, and are extending their ravages, some as transmission agents for sleeping sickness and others as the carriers of the deadly disease of nagana among cattle. The epidemic in Uganda some 20 years ago killed off about ten per cent. of the population ; but the cattle-killing is even more devastating though less spectacular ; for the people who escape sleeping sickness are driven out of the country for want of the cattle on which they depend for a living.

The mosquito, as the host of the malarial parasite, is responsible directly for a large fraction of the 4-5 million deaths annually returned as due to "fevers" in India alone, without regard to the amount by which the lives of many millions more are shortened and those of still larger numbers made less efficient and more liable to succumb to other diseases.

On the other hand, insects carefully cultivated may be of immense economic value. The product for example of the lac insect exported from India annually amounts to over 7 million sterling. The silkworm in Japan alone produces material of the annual value of over 60 millions.

It is important, too, to consider the magnitude and difficulty of dealing with an insect scourge. We speak loosely of the tsetse-fly and the mosquito, but there are dozens of distinct species included under both of these vague names. Most are irritating, many deadly dangerous ; but, in adopting curative and preventive measures against noxious insects, the entomologist has to discriminate with precision between species which to the general public pass under comprehensive terms, but which in structure, in habits, in usefulness and in destructive activities differ as much as a man differs from a monkey. Even more meticulous precision is necessary in encouraging the development of beneficial insects ; for in this matter discrimination is necessary not between one species and another only, but between varieties and races differing from one another as the greyhound differs from the sealyham. And

* In the 55*th Ann. Rep. Ent. Soc. Ontario for* 1924 (pp. 30-46) C. L. Metcalf estimates the total annual damage done by insects to staple crops in America alone at £165,000,000. In spite of the commendable development of entomological services in America, it is probably difficult to obtain any precise figure, and precision matters little; for to obtain a contrast between the cost of the entomologist and that of the insect a few millions either way does not affect the ratio appreciably.

in the class of insects the number of distinct species can be described only as colossal. The work of identification in Entomology has become so voluminous that several specialists for this work alone are now necessary, and the correct identification of species is but a preliminary step in the much larger and more difficult problem of studying their life habits and then of adopting safe and suitable measures for their development or their destruction. Many of the most serious instances of widespread damage to agriculture have arisen from species which have been accidentally introduced into a new country without their natural parasites, so that they have been able to increase to an abormal extent in their new environment. It requires very little imagination to realise the kind and quantity of work necessary to discover and repair such mistakes.

If we estimated the importance of Economic Entomology only by the damage done by pests to crops, it would be obvious that the cost of any research operations so far contemplated by any civilised Government is negligible. But the damage done to cultivated crops is not the only or even the greatest economic loss due to insects which prey on the forests, on wild plants of value and on all animals, including man, both by direct attack and as carriers of disease.

Most civilised countries employ entomologists to some extent, but I am concerned just now only with the kind of machinery devised for correlating activities through the Empire. The Imperial Bureau of Entomology at South Kensington was the only one of its kind that was brought into being before the Great War. It arose from the Entomological Research Committee which was founded in 1909 to stimulate investigation in connection with the injurious insects of Tropical Africa, especially those that transmit disease. In 1913 it was decided to extend the organisation to deal with Economic Entomology throughout the Empire, and it is now supported financially by annual contributions from 45 Governments of the Dominions and Colonies, in addition to £1,000 from the Imperial Government, giving it a total revenue of £11,800. The extent to which this bureau is used by official Entomologists in the Dominions and Colonies is shown sufficiently by taking one only among its many activities, namely, the identification of insects, which requires comparative work in a comprehensive collection like that of the Natural History Museum. During the past five years an annual average of 50,000 insects have been examined by the staff of the Bureau.

The other activities of the Bureau include the production of a Review of Applied Entomology, in which, during the past five years abstracts of articles to the number of 2,309 annually have been issued for the benefit of independent and isolated workers who have not, naturally, access to more than a fraction of the 1,200 periodicals in which the articles appeared in various languages. Another obviously useful function of the Bureau is the distribution to universities, hospitals and Government institutions of identified specimens of

species known to be of economic importance. In all about 27,300 insects were thus distributed between 1920 and 1925. One of the most recent activities of the Bureau is the distribution to various parts of the Empire of parasites likely to be destructive to insect pests. The importance of this work must be obvious to everyone: the difficulties and dangers that attend it are fully appreciated only by the biologist.

One can form an imperfect appreciation of the kind of organisation required for work of this kind—organisation and administrative capacity at the head, tactful tactics in curtailing its sphere of influence over those who are jealous, often properly so, of their own state establishments, and conscientious devotion to work involving a mass of mechanical, often dull, routine which can only be of real value if carried on with meticulous precision and rigid faithfulness. To Dr. Guy Marshall and his faithful colleagues the Empire owes a real debt, and the best way to pay the debt is to increase their work. That the work of the Bureau is appreciated is shown by the number of Governments that support it. That the degree of appreciation varies is shown by the range of annual contributions from £25 to £1,000, but in no case does the amount devoted to this object form an appreciable fraction of the direct financial importance of Economic Entomology. There is room still for expansion in various directions, without fear of overlapping those activities that can be most efficiently performed locally.

I have dealt with Entomology at some length, because to most people insects are familiar as friends and foes, and no subject could better illustrate the importance of co-operation between workers in different parts of an Empire covering such a large share of the tropical zone. But it is only because of our ignorance of damage done by other forms of life that we fail to recognise equally the importance of similar action in other branches of biological control.

MYCOLOGY.

Mycology is a subject that possibly comes next to Entomology in the width and intensity of its bearing on the raw materials of an Empire largely dependent on vegetable products, whether cultivated in fields or wild in forests. Diseases of plants caused by fungi form losses of unknown, but certainly great, dimensions in the temperate as well as in the tropical zones, and plants are not the only victims of parasitic fungi.

There are nearly 100 official mycologists in overseas parts of the Empire, most of them attached to Government Departments of Agriculture. Generally they have excellent laboratories and research stations, but this development of science accessory to Agriculture and Forestry is relatively young, and these workers consequently have limited opportunities for access to authentic specimens of parasites, with insufficient literature recording the results obtained elsewhere. The necessity for co-operation is obvious, and fortunately as the result of discussion at the Imperial War Conference in 1918, the Colonial

Office was enabled to initiate proposals for the formation of an Imperial Bureau of Mycology on lines similar to those which had proved already to be successful for Entomology. The originators of the scheme were fortunate in finding the right type of specialist ready and able to organise the work; for Dr. E. J. Butler, as a successful "plant doctor" in India and Malaya, had acquired the necessary experience for visualising the difficulties which isolated plant pathologists had to face; he was relieved of official duties by his Government to commence the work of Director of the new organisation in 1920.

The Bureau of Mycology is financed by contributions from the Dominions, Colonies and Protectorates amounting annually to £5,500, no grant being made by the Home Government. The programme which the Bureau aims to fulfil includes the work of identifying injurious fungi and diseases referred by workers in overseas parts of the Empire, in addition to the dissemination of information through its Monthly Review; but for want of trained workers it has not been possible so far to undertake all that is desirable and would obviously be useful in helping investigators with identification problems that are refractory or insoluble in areas far away from authoritative reference collections.

Thus the chief work done by the Bureau during the first five years of its existence has been that of a clearing house of information for the benefit of overseas workers. The current volume of the *Review of Mycology* contains some 1,500 abstracts from 450 periodicals published in various languages, and the regular issue of this monthly *Review* has formed the main function of the Bureau so far. But information in other ways is supplied to working specialists, copies of papers and reprints of summaries are lent freely, and overseas Governments are kept in touch with the progress of legislation intended to assist in the suppression of plant diseases.

The development of the information part of the Bureau has paved the way conveniently for more direct assistance in the essential work of identifying obscure and little known parasites; for the work which has been done in recent years on areas previously untouched now forms a substantial foundation for advance.

For the immediate purposes of our present discussion, the limit set by the Bureau on its own functions is as important as the outline of what it actually undertakes. It definitely avoids research as such on plant diseases, for the Director realises, from his own field experience, that this can be done effectually only by local workers, either in Britain or overseas. The enthusiasm of scientific workers incurs the constant temptation to go beyond their last, with the consequent liability of trespass.

The work done by central institutions like the Bureaux of Mycology and Entomology is available to more than official workers in the overseas parts of the Empire. The more enlightened associations connected with the planting industries know their practical worth, such, for example, as the Indian Tea

Association, the Rubber Growers' Association and the Colonial Sugar Refining Company of Australia.

MINERALS.

Another bye-product of war enthusiasm was the Bureau designed to assist the mineral development of the Empire. It arose from the resolutions of the Imperial War Congress in 1917, and was granted its Charter on the 12th June, 1919, having for its main functions—(1) collecting statistics of mineral production, exports and imports, both for the Empire and foreign countries, for it was considered important to know the possibilities of the latter as competitors and customers; (2) accumulating information as to the occurrences of minerals and the uses to which they could be put; (3) disseminating this information to all who would profit by it; (4) collecting and publishing details of the mining laws and regulations in force in different parts of the Empire, and advising the Governments in the enactment or amendment of such laws and regulations; (5) promoting co-operation between firms interested in mining and metallurgy, and between them and research workers in the universities and public institutions as well as with overseas Governments.

In the early days of the Bureau it was financed by the British Government, but from 1920 onwards it was to be supported jointly by the United Kingdom, the Dominions, India, and the Colonies. In that year £10,000 was supplied by the first-named, and about £9,400 by the remainder. In addition £1,000 was paid by the National Federation of Iron and Steel Manufacturers for a special publication on iron-ores. That year represented the high-water mark of the finance of the Bureau. In the face of the commercial depression which followed and the rival claims of the Imperial Institute, the Dominions and Colonies reduced their contributions, whilst the British Government limited theirs to the total received from the other Governments, so that the income of the Bureau was ultimately reduced to little more than £10,000.

After being threatened with extermination it was amalgamated last July with the reconstituted Imperial Institute, in the hope that thereby some unnecessary overlapping of effort might be prevented and money might so be saved.

TRADES' RESEARCH ASSOCIATIONS.

The Trades' Research Associations are supported by firms engaged in certain technical industries, such as the textile industries, rubber and tyre manufacture, cocoa and confectionery, non-ferrous metals, refractories and electrical industries. Altogether 25 of these have been launched and all but two are still active. To the general student of affairs organisations of this sort must always be of interest, especially in a country where there has been a tendency for competing firms to guard from the public and from one another, through shyness or the supposed commercial advantages of their special methods, the intimate and domestic details of their operations.

Some detached and disinterested precipitant, as a chemist would say, was required to bring competitors into active co-operation; for evidently even recognised improvements must sometimes be of doubtful value when their adoption necessitates the scrapping of capital already invested in plant and machinery suitable for established methods. Although the firms individually could not undertake the research work necessary for definite advances in manufacture, a scheme that threatened to cut across the marked individuality of British manufacturers was naturally regarded at first with caution and occasionally with suspicion. The initiation was thus taken by the new Department of Scientific and Industrial Research.

In practically every case the scientific verdict on the work leaves no room for doubt as to the potential value of Research Associations to the industries with which they are associated. But while the industries for the most part are ready enough to admit in the abstract the need for and value of scientific research into their processes and methods of manufacture, they almost without exception plead that they cannot afford, in the present bad state of trade, to raise unaided the funds necessary to establish their Research Associations on a stable foundation. Yet, in comparison with the value of the trade in which the industries are engaged, the sums required for the continuance of the work of existing Research Associations are astonishingly small. A few examples will make this clear.

The British Cotton Research Association spends about £45,000 a year on its work, whilst the annual value of the raw cotton imported and retained for manufacture is between 50 and 60 million sterling. In other words, another farthing added to every pound sterling paid for their raw material represents the cost to the manufacturers of investigations recognised by them as commercially valuable. Similarly, a penny added to every pound paid for imported wool and a halfpenny to every pound's worth of rubber represent the amounts respectively spent by the two corresponding associations. Neither the Government nor the manufacturers have hitherto fully appreciated the fact that so far as production costs are concerned, the maintenance of research workers is still a negligible item. It is interesting therefore to see a Committee of the Privy Council finding it easy to justify its existence. In their last Report just issued one finds them referring to the fact that it is intended this year to spend £40-million on the erection of small houses to meet some of the recognised shortage, and one finds from the returns of the Advisory Council, given in an appendix to the same Report, that they have spent £11,940 on building research during the past year; that is to say, for a third of a farthing added to each pound spent on the small houses alone, information is being obtained which will ensure that the money is better spent. Three years ago an Act was passed to raise funds to provide better amenities for coal-miners. The levy of one penny a ton on coal raised produces a million sterling annually. What would our technical industries be like if

we had spent a million a year on industrial research from the commencement of the new century?

EMPIRE COTTON GROWING CORPORATION.

The Empire Cotton Growing Corporation, which received its Charter in 1920, might be regarded as a super-Research Association. The formation of this body deserves more than a passing mention; for whilst its scope is analogous to that of the various Trade Research Associations, it is on an exceptionally large scale, covering activities in all parts of the Empire. Thus, the Corporation differs from the other Research Associations in being imperial rather than merely, or mainly, national. It has unusual powers in its relations to the manufacturing industry, which, because of its size and financial value, is conspicuous in its national importance.

Before the War the value of cotton goods exported amounted to £127 millions out of a total of £411 millions for manufactured goods of all sorts; and these figures only partially express the value of the industry; for one eighth only of the raw cotton imported went out again in the form of manufactured articles. The capital invested in the industry amounts to some £500 million and the whole of it depends for its existence on raw material obtained from outside, mainly foreign, sources.

When it is realised that cotton growing countries are rapidly extending their own mill capacity, and have the power to assist their industries by restricting the export of the essential raw material, the danger of relying on foreign sources for it becomes obvious, even alarming. The effect of the American Civil War should have been a sufficient warning of the risks to which the industry is exposed, but subsequent prosperity with a gradually rising curve to represent output and values effectually lulled all fears till the Great War came and stirred our cotton magnates afresh. The financial stresses which followed the war reinforced the conclusions of the Birchenough Committee; for the price of American cotton showed no sign of adjusting itself to the reduced purchasing power of Europe. The outturn of the cotton fields fell off for various accessory reasons, whilst mills in the United States increased their demand for the raw material, and even indicated the possibility of America itself becoming a serious competitor for outside supplies, including the fine Egyptian varieties.

To the commercial enterprise and mechanical skill of the people of Lancashire we were originally indebted for turning to account certain natural advantages of their county in climate and fuel supplies. To the public spirit and co-operative disposition of their leaders also we are now indebted for this new and remarkable effort to make the Empire self-contained and independent of outside sources. It is true that the great effort now being made by this Corporation would not be possible without State aid, financial and legislative; it is nevertheless the direct product of Lancashire enterprise,

for the Corporation is the lineal descendant of the British Cotton Growing Association which was formed in 1902. The powers and resources of the Association, however, did not permit its influence to be felt much beyond the African fields, and something wider was wanted—an association with resources sufficient to combine the agricultural with the manufacturing problems, and sufficient to afford to wait many years for the results necessary to ensure stability for the industry.

The new Corporation derives its income partly from a capital contribution of nearly a million granted by Government and partly from a levy of sixpence per standard bale on all cotton purchased by spinners in this country. This levy, in accordance with the wishes of the trade, has been made obligatory on all spinners by an Act of Parliament which received Royal Assent in July, 1923.

The progress of the Corporation can be estimated by the reports and papers which are issued quarterly in the Empire Cotton Growing Review, which began in January, 1924. From this it will be seen that, in addition to the staff at Millbank House, which is the headquarters, there are various specialists in South Africa, Rhodesia, Swaziland, Nyasaland, Sudan, Uganda, Queensland and the West Indies.

The Corporation is in touch with the official agricultural services in India, the Dominions and Colonies; it finances research work at Cambridge, Manchester, Rothamsted and the Imperial College ; it is developing a scheme of training post-graduate students to recruit its overseas staff, and its latest enterprise is the establishment of a central research station in Trinidad for the purpose of investigating the cotton plant in all phases of its growth and under conditions rigorously controlled.

The only comment that I feel safe in making on this remarkable enterprise is that Lancashire does not intend, and is not likely to be forced, to give way to competitors elsewhere ; and if it ever changes its religion on fiscal questions it will have merited protection by showing a readiness to fight on fair trade lines without artificial help.

Indian Cotton Committee.

It is necessary to mention that the Corporation here has been closely followed by a similar organisation, but with a more limited range of action, in India. Following the investigations of a Special Committee which reported early in 1919, the Indian Central Cotton Committee was constituted by resolution of Government on the 31st March, 1921, and its efforts have been supported by subsequent legislation. The Cotton Cess Act, which was passed in February, 1922, gives the Committee the benefit for the first three years of four pence on every bale of cotton consumed in Indian mills or exported, and two pence per bale thenafter. The Committee, with an assured income on a large scale, is planning research work in agriculture as well as in manufacturing problems, and its efforts will be supplemented by the Cotton Transport

Act of 1923, which is intended to limit the evils due to mixing of good and less valuable strains in the course of cross-country traffic.

Dominions.

I have already referred to the fact that, after the institution of the Department of Scientific and Industrial Research in this country, corresponding organisations were set up in the Dominions and India. With the close of the war these underwent changes in constitution and functions which are worth careful study.

The idea originated in Australia, and, although arrangements were devised to meet demands made on the Commonwealth during the war, the Australian National Research Council began its first session in August, 1921. The Commonwealth Institute of Science and Industry had been, however, organised a year before, and its constitution was adopted by an Act passed in September, 1920. The Act lays down that the Director shall, as far as possible, co-operate with the existing State organisations in the co-ordination of scientific investigation, with a view to the prevention of unnecessary overlapping and the utilisation of facilities and staffs available in the States. Powers are given for arrangements to be made for co-operation with State Government Departments, universities, technical schools, educational authorities and scientific societies, not only as regards the conduct of actual research, but also with a view to advancing the teaching of science, the training of investigators in pure and applied science and of technical experts, and the training and education of craftsmen and skilled artisans.

The progress of the Institute has been restricted for want of funds. The total vote in 1922-23 was £20,907; but, on the 30th May, 1925, the Prime Minister called a conference to discuss the future, and a scheme for expansion was adopted involving an estimated annual expenditure of £100,000. The provincial patriotism in Australia, which persists as a consequence of the original settlement in independent and well separated States, makes co-operative action slow, but is an insurance against over-centralisation. The operations of the Commonwealth Institute are not likely therefore to displace the research work being conducted in the universities and other State institutions.

In Canada the Honorary Advisory Council for Scientific and Industrial Research was formally constituted by an Act which was passed in August, 1917. Subsequent annual reports show that the Council considered it essential that a National Research Institute should be built to supplement its work of assisting research in various established institutions. On the 19th July, 1924, fuller powers were granted by an Act of Parliament which declared that, " the duties of the Council shall include the charge of all matters affecting science and industrial research in Canada which may be assigned to it, and also the duty of advising the Committee of the Privy Council on Scienti-

fic and Industrial Research on questions of scientific and technological methods affecting the expansion of Canadian industries or the utilisation of the natural resources of Canada."

In South Africa the Industries Advisory Board was established on the 2nd May, 1917, and arrangements were made to ensure co-operation with the adjoining South African Protectorates and Rhodesia. The duties of the Board were transferred to the Department of Mines and Industries in 1923, and the functions of this Department now resemble those of the Research Department in this country in providing for co-ordination within the Union and co-operation with institutions overseas.

The Department of Industries and Commerce in New Zealand undertook in 1917 similar functions, necessarily on a smaller scale, for the Dominion.

So far as administrative machinery goes, it is obvious that all the Dominions have systematically reviewed the various facilities and necessities for research: the machinery has also been adapted to suit the special conditions of each country. The only feature on which one feels tempted to comment is that arising out of the Canadian proposal to build a special Institute for the Dominion. In this country the Research Department confines its executive action to the direct control of specialised institutions, such, for example, as the National Physical Laboratory, the Fuel Research Board, the Building Research Station at Acton and the Geological Survey, which last, as a strange British tradition, has always fortunately been treated as a separate national institution in each Dominion except Australia. Even these are controlled by Boards so constituted of scientific men that parts of the work and related researches already carried on in independent institutions are intelligently supported.

There is an obvious danger in the activities of central, compound, or general institutes of research. Research workers have always more ideas in their heads than they can readily develop and complete in practice. They always hope to find time to work out problems for which they feel an inspiration, and they naturally hesitate to pass them on to others. This influence of normal human nature is relatively harmless in a specialised institute; for when a deferred problem is tackled, it is worked out thoroughly. But the temptation to reserve a "claim" is stronger in a general institute, and its resultant dangers are more serious; for its governing body represents ordinarily the financial interests which support the institute, instead of being composed of critical specialists. This, I think, has been the disadvantage under which the Imperial Institute has suffered. The most useful service that a general institute of the sort can perform is to pass on problems to specialists, putting the enquirer and the scientific worker into direct touch, contenting itself by becoming a clearing house for information, especially in the direction of knowing who's who and what each is doing in the scientific and industrial world. The success of the Department of Scientific and Industrial Research

has been due to a faithful recognition of this principle, and its perpetual observance from the start was ensured by the creation of the Advisory Council in 1915.

INDIA.

India, which was provided with a suitable administrative organisation before the war and whilst it lasted, is the one conspicuous example of subsequent disintegration. In India the necessity of co-ordinating official activities in scientific research was recognised by Sir Denzil Ibbetson as long ago as 1903, when a Board of the principal officers of the scientific departments was formed. One of them was appointed as Secretary, and fortunately, it was the distinguished botanist on whom His Royal Highness conferred the Albert Medal last July and who is present to-night to accept our recognition of his Birdwood Memorial Lecture.

Following the expansion of scientific services devoted to the investigation of raw materials, the Government of India in 1916 appointed a Commission to advise on measures necessary for developing the manufacturing industries, and the Commission recommended large increases of the scientific services based on an extension of technological education, with a scheme for the co-ordination of private as well as official work, both imperial and provincial. Soon after the Commission reported, the Government of India Act of 1919 came into force, and, with it, the failure to recognise the fundamental distinction between advisory and executive functions. Evidently, in advisory work the requisite degree of thoroughness can be obtained only by employing specialists, and these cannot be maintained in sufficient variety by each of the nine provinces, with their problems of unlike nature. For executive functions, promptness and a familiarity with the peculiar local conditions are the dominating requisites. The policy of provincialising industrial research of all sorts has, however, been adopted without discrimination, and most of the proposals of the Industrial Commission must accordingly remain fruitless, until India discovers that no modern country can face the commercial competition of peace time, or defend itself in war by merely repeating maxims of political theory. India is now being doped with fiscal protection instead of being prepared by industrial training to develop its own natural resources in a healthy way. If the present course is followed, India will become still more dependent on outside sources for manufactured articles, which naturally are continually changing in form and increasing in variety for civil as well as for military activities.

The country will be forced to go outside for its requirements in some forms of food, as it is doing already on a large scale for sugar. Natural indigo, exported in large quantities has already been displaced by the chemical product of European science. What science has done in Europe it should be able to do still better in a country with natural climatic advantages, but not by processes which are translated unmodified from other countries. Improve-

ments in agriculture and processes of manufacture must be based on research in India itself under Indian conditions, not on reports made on samples sent to the Imperial Institute. Unless research workers are specialists they are dangerous, and the requisite number and variety of specialists, with their equipment, can be maintained only by the co-operation of all provinces. Recent movements in India have been in the opposite direction, and the result must necessarily be a loss of natural economic advantages; so far as raw materials are concerned, the place hitherto occupied by India will be usurped by Central Africa, and for manufactured goods she will become more and more dependent on Japan, Europe and America. In industrial problems, India is not now being helped to work out her own salvation, but is being allowed to prepare for an entirely different destiny.

United States.

In spite of the length of this Address, the omission to mention many movements and institutions must be obvious to everyone who has been conversant with the developments of recent years. To resist the temptation to follow up many side issues has been very difficult, but I may be pardoned if I refer very briefly in conclusion to what is being done in America; it shows how modest is our scale of operations even now.

The National Research Council in the United States is entirely a co-ordinating agency, and its financial resources are devoted mainly to the maintenance of its own administrative machinery. During 1921-22 the Council estimated that the equivalent of about £6,000,000 was spent on research in applied science, about one-third of the money being obtained from the National and State Governments. The area affected is of course more compact and uniform than the British Empire, but the degree of authority and activity of each of the States justifies some regard being paid to the relative amounts which are devoted to the work.

The data of most instructive value are those relating to the specialised Bureaux at Washington, for they approximately correspond to the ideal set out originally for the Imperial Bureaux that we have established in London. Under the Department of Agriculture there are seven Bureaux of the sort, and for purposes of comparison, or rather contrast, we might take that devoted to Entomology for which this year the equivalent of just half-a-million sterling has been voted, against our £12,000. The expenditure at Washington does not include the sums spent by the individual States, some of which maintain services comparable in size to those of our Dominions. The Bureau of Entomology is by no means the largest; but we need not consider the others or our Treasury officials would blush; nor should we comment on where the money comes from or our friends at Washington might do more than blush.

Conclusion.

I think our members will agree that at last we have completed in skeleton form at least, a scheme for a systematic organisation, which, if developed faithfully, will be suitable for imperial as well as for national needs. The course of evolution has been slow and has been accompanied by many side steps; indeed, has been typically British. The organism has now acquired the essential structure of its species, but we have yet to shed, or, I hope, to absorb and more fully utilise, such vestigial organs, for example, as the Imperial Institute, that have served an ornamental and, in their own times, a useful purpose, in spite of the fact that, like all such superseded vestiges, they have caused some inconvenience to the general body. We have in this country now laid substantial foundations in the Department of Scientific and Industrial Research, and we have made plans for an Imperial superstructure, but the plans of a house, no matter how well drawn, offer insufficient shelter for the householder; there is still much to be done by way of building and still more by way of furnishing, all of which requires money and building materials in the form of research workers, which our universities, if adequately supported, should be able to supply.

The Chairman then presented the medals for Papers and Lectures given during the last session, as follows:—

Papers read at the Ordinary Meetings:—

Llewelyn B. Atkinson, M.I.E.E., Past-President of the Institution of Electrical Engineers, "The Scientific Principles of Artificial Incubation."

C. F. Elwell, B.A., "Talking Motion Pictures."

Mrs. Graydon-Stannus, "Irish Glass, Old and New."

Emile Cammaerts, "The Restoration of Belgian Towns."

Claude N. Friese-Greene, "The Friese-Greene Process of Colour Cinematography."

Henry G. Dowling, "Wallpapers."

Lieut.-Colonel Andrew Balfour, C.B., C.M.G., M.D. (Edin.), B.Sc., D.P.H., F.R.C.P.E., "The Trend of Modern Hygiene."

Papers read in the Indian Section:—

Lieut.-Colonel R. McCarrison, C.I.E., M.D., B.Ch., LL.D., D.Sc., F.R.C.P., Indian Medical Service, "Problems of Food, with Special Reference to India."

Sir Henry Sharp, C.S.I., C.I.E., "The Development of Indian Universities."

Sir Gilbert T. Walker, C.S.I., Sc.D., Ph.D., F.R.S., F.R.A.S., "Indian Meteorology."

Paper read in the Dominions and Colonies Section:—

R. H. Brackenbury, Member of the Empire Cotton Growing Corporation Mechanical Transport Sub-Committee, "Transport in Tropical Africa."

Trueman Wood Lecture :—

Sir Ernest Rutherford, O.M., LL.D., D.Sc., F.R.S., Cavendish Professor of Experimental Physics, University of Cambridge, "The Stability of Atoms."

Sir George Birdwood Memorial Lecture :—

Lieut.-Colonel Sir David Prain, C.M.G., C.I.E., LL.D.,. F.R.S., "Government Botanic Gardens."

DISCUSSION.

Lord Askwith, K.C.B., K.C., D.C.L., said he was sure the members of the audience would wish to accord a hearty vote of thanks to Sir Thomas Holland for the very interesting address which he had given that evening. Sir Thomas had given utterance to remarks which would spread throughout the Empire when published in the *Journal*. That was one of the most important things connected with the *Journal*—that those who spoke before the Royal Society of Arts had an audience which was not confined to this country alone.

Sir Thomas had spoken of many things which had originated from learned Societies, and also of various organisations and movements which had occurred since the war, or perhaps partly in consequence of the war. He had made the remark that the Empire had awakened for the first time to the fact how isolated it might be in time of war, particularly owing to the submarine and to the aeroplane, and to the fact that it had to go largely upon its own resources. Whether, if there was another war, the same effect might be produced might possibly be doubtful. It might be that in the next war, owing to aeroplanes, we might have even better communication with a country like India than had been the case in the last war. However, he (Lord Askwith) did not attempt to prophesy ; he merely pointed out that the isolation to which he had referred had caused a tremendous accession of scientific research and of interest in this country, and that it gave the opportunity to Sir Thomas Holland, among others in India, to do things for that country which were of very great value.

Sir Thomas Holland came from Canada to England and had been educated here, and he was an example of those men who had found in the East an opportunity for a career which had brought honours and respect. He had gone to India and passed many years there, and there came a time when his services were notably required. He had worked in innumerable Associations ; he had studied petrology, geology and anthropology in detail in that country ; he knew India well and, when India was cut off, he could devote himself to munitions of war and to organisation from knowledge of the country and the people, and of what was in the country.

Now Sir Thomas had come home, and was Chairman of the Council of the Royal Society of Arts, and—he was still a young man ! Sir Thomas had pointed out some things of particular interest. He had made remarks, rather of a strong character, with regard to India, which an ordinary Englishman, who did not know India, might not have ventured to suggest, but he spoke with knowledge of India. Personally he hoped these remarks would call the attention of India to the importance of research even more than many persons who were at present in that great country seemed to have realised. India was a country with very varied and interesting peoples, with very varied resources and with a very ancient civilisation. The Royal Society of Arts had paid particular attention for many years, under the

able assistance of Mr. Digby, whose death as Secretary of the Indian and Dominions Sections everyone regretted, to India as well as to the Dominions. It had had on its Council a large number of ex-officers of the Indian Services. The members were glad to welcome as their Chairman another distinguished Indian officer, and he trusted Sir Thomas would have an exceedingly successful year.

LT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., F.R.S., in seconding the vote of thanks, said that after Lord Askwith's words he did not think it was necessary for him to say anything with reference to the Chairman that evening in respect to India, but he would like to say how much he personally appreciated, as he was sure everyone present appreciated, what Sir Thomas had said about the Royal Society of Arts. He, Sir David, thought with gratitude of the great encouragement which the Society had given to one very distinguished predecessor of his own at the end of the 18th century and the beginning of the 19th century; he thought with equal gratitude of the assistance which a Secretary of the Society had rendered to another predecessor of his when he had dealt with all the specimens of timbers which he had brought home from India somewhere about the year 1829; and he thought also with gratitude of what the Society had done, by means of its examinations, when a generation later it had given a stimulus to one of the most loyal and trusted colleagues whom he had had at Kew and which had led that colleague to enter on a distinguished scientific career.

Sir Thomas had said in one part of his Address how the Royal Society of London, unable quite to cope with all its duties, had had to delegate some of them to the Royal Society of Arts. In one of the oldest Statutes of the Royal Society it was laid down that the duty of those who belonged to it was to consider natural facts, and thereupon to consider how far they or any of them might be improved for use or discovery. As a matter of fact the foundation of the Royal Society of Arts did not, in his judgment, relieve the Royal Society of the duty which was imposed on it. It still remained the duty of the Royal Society to improve natural knowledge for use, from the point of view at any rate of the science involved; but on the Royal Society of Arts did devolve the duty, he thought, of improving natural knowledge for use from the point of view of the industrial or commercial interests concerned. As a matter of fact, such was the tendency of human things, the Royal Society of Arts had been left to undertake both duties, and one knew how well the Society must have performed them from the fact that when it became later on necessary to found an Association for the advancement of science (which he took it was the improvement of natural knowledge for discovery) it had not been regarded as necessary to found an auxiliary Association to help the Royal Society of Arts.

Another thing which not only he himself but he was sure others who were present must be very grateful to the Chairman for having urged, was the absolute necessity of paying attention from the very outset to the drudgery and the hard work which was involved in identification in subjects such as entomology, which Sir Thomas had described so lucidly and eloquently. In his own case, happening to have been taught the duty of attending to the characters and qualities of natural objects, he had been confronted with a time when it had become recognised that equal attention was necessary to the structure and function of natural things. The unfortunate point in those early days had been that those who embarked on the new duty of attending to structure and function seemed occasionally to think, as he thought the Royal Society itself at one time thought, that because something new had to be done, therefore the old work was no longer necessary. He had much pleasure in seconding the vote of thanks to Sir Thomas Holland.

THE CHAIRMAN, in reply, thanked the audience for the very cordial way in which they had passed the vote of thanks. Still more he thanked them for the very patient hearing which they had given him in his attempt to deal with a very complicated problem. At any rate the Address had given rise to two very interesting speeches. Sir David Prain, who had paid more attention to the history of science and scientific institutions than anybody else of whom he knew, spoke with authority when he stated that the Royal Society had not done all it might do when it had not paid the same amount of attention to applied science as possibly the Royal Society of Arts had done. It could not do both. There was room for both Societies obviously now to carry on their work. The Royal Society had certainly devoted its attention to applied science and was responsible for original and new work ; but the Royal Society of Arts had the duty of translating the results of scientific workers for public consumption.

The Council of the Royal Society of Arts had a great deal of business to do to which fortunately its members were not compelled to listen or to follow. The membership numbered some 3,500, which naturally gave rise to a good deal of business which had to be transacted by the Council. Although he was one of the most junior members of the Council, he was quite sure from the cordial co-operation he had received so far from Lord Askwith and the other colleagues that he would at any rate have an opportunity of producing a successful year of office, although certainly he would not be able to equal the record of attending so regularly and doing the business so punctually which Lord Askwith held.

GOVERNMENTAL ASSISTANCE TO AMERICAN FOREIGN TRADE.

By an Act of Congress passed in 1912 the United States Bureau of Foreign and Domestic Commerce, a branch of the Federal Department of Commerce, whose functions correspond closely with those of the Department of Overseas Trade in London, was created, and has ever since received the active support of American trade associations and individual business concerns. Since 1912 the Bureau has devoted practically the whole of its effort to the advancement of American export commerce by keeping in touch with commercial and financial conditions, discovering trade opportunities, and removing difficulties from the path of American traders in foreign countries. Latterly it has also been entrusted with the compilation of import, export and other statistics, as well as with the administration of the China Trade Act passed in 1922 to enable the United States firms in China to trade under an American Federal charter. In the earlier part of its history the appropriations set aside by Congress for the use of the Bureau were small and its activities were somewhat restricted in consequence, but during the last four or five years its work has come to be regarded as essential and the appropriations have been heavily increased. The expanding importance of the Bureau can best be appreciated from a statement of the sums voted annually by Congress to cover cost of working:—

Fiscal Year.	Total Appropriation. $	Fiscal Year.	Total Appropriation. $
1913	159,422.28	1920	936,416.89
1914	224,860.00	1921	972,422.90
1915	396,989.59	1922	1,306,844.41
1916	421,280.00	1923	2,262,160.68

1917	506,640.00	1924	2,876,110.00
1918	545,452.48	1925 (budgeted) ..	3,165,372.00
1919	896,021.65		

With the aid of the larger resources provided during the last three years the efficiency of the Bureau has been greatly increased, and its range of activity widely extended under the guidance of the Secretary of Commerce. At the present time it directs the work of over thirty commercial attachés and trade commissioners stationed at strategic trade centres in as many different countries.

According to the recent annual Report by the Commercial Counsellor to His Majesty's Embassy in Washington, one of the principal reforms instituted in the internal organisation of the Bureau has involved the creation of Commodity Divisions which correspond in general with the Trades Sections of the Department of Overseas Trade. Each of these divisions deals with all questions relating to a particular product or group of products entering largely into American export commerce. On July 1st, 1923, there were 19 commodity divisions comprising the following:—Agricultural implements, automotive, chemicals, coal, electrical equipment, foodstuffs, hides and leather, industrial machinery, iron and steel, lumber, nitrogen, paper, petroleum, rubber, shoes and leather manufactures, sisal, specialties, textiles, and transportation and communication.

Each commodity division works under the direction of an expert paid by the Government, but selected by the members of the trade concerned or by their representative association. Particular care is exercised in the choice of these experts, and their employment has been signally effective in inspiring general confidence in the practical character of the work carried on and is responsible for much of the success that has attended the recent activities of this governmental agency.

The commercial intelligence functions of the United States Consular Service are almost exactly similar to those of the British service, and, therefore, require no detailed description. The commercial reports are passed on by the State Department to the Bureau of Foreign and Domestic Commerce and thence distributed through the nine district offices and 24 co-operative offices of the latter in the principal commercial centres of the United States. In 1920 the State Department made provision for the appointment of about 25 special "Economic Consuls" to be attached to the more important consular posts and to devote the whole of their time to the preparation of economic reports and to trade promotion work generally. Proposals are now under consideration for bringing all the commercial work of the Consuls under the direct supervision of the American commercial attachés abroad, as there is a growing belief that efficiency and economy would be thereby promoted. This reform, if carried out, would bring the American practice into exact conformity with the practice that has always obtained in the British system.

GENERAL NOTE.

The Merchants' Association of New York.—This Association, which comprises the leading corporations and firms in New York, has for one of its objects the placing of foreign houses wishing to buy or sell merchandise, or to make agency arrangements in the United States, in direct touch with prominent American firms.

For this purpose a complete and carefully organised card index is maintained showing the overseas business interests of thousands of American houses. The Association offers to assist any Fellows of the Society anxious to avail themselves of its services, without any cost whatsoever, and invites them to communicate with the Secretary, Merchants' Association of New York, Woolworth Buildings, New York City.

MEETINGS OF THE SOCIETY UP TO CHRISTMAS.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock (unless otherwise announced) :—

NOVEMBER 25.—DAVID GREENHILL, Director and General Manager, The Sun Engraving Company, Ltd., "Colour Printing." SIR ERNEST HODDER-WILLIAMS, C.V.O., will preside.

DECEMBER 2.—LIEUT.-COLONEL SIR ALAN H. BURGOYNE, M.P., A.M.Inst.A.E., "The Future of the Motor Car." COLONEL SIR THOMAS A. POLSON, K.B.E., C.M.G., will preside.

DECEMBER 9.—At 4.30 p.m.—(Joint Meeting of the Indian and Dominions and Colonies Sections.)—A paper on "The Imperial College of Tropical Agriculture," by H. MARTIN LEAKE, M.A., Sc.D., F.L.S., Director of the College, will, in the absence of the Author, be read by ARTHUR WILLIAM HILL, Sc.D., F.R.S., Director, Royal Botanic Gardens, Kew. The RT. HON. L. S. AMERY, M.P., Secretary of State for the Colonies, will preside.

DOMINIONS AND COLONIES SECTION.

TUESDAY, NOVEMBER 24th, at 4.30 p.m.

MRS. JULIA W. HENSHAW, F.R.G.S., C.de G., Director of National Parks Association, Canada, "The Canadian National Parks." THE RT. HON. LORD BLEDISLOE, K.B.E., Parliamentary Secretary, Ministry of Agriculture and Fisheries, will preside. The lecture will be fully illustrated with slides painted by the author. (Dr. Mann Lecture.) Tea and coffee will be served in the Library at 4 p.m.

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

R. LESSING, Ph.D., F.C.S., M.I.Chem.E., "Coal Ash and Clean Coal." Three Lectures. November 23, 30, and December 7.

LECTURE I.—The economic significance of the mineral constituents of Coal. Distinction from Ash. Ash from Fusain, Durain, Clarain and Vitrain. Origin of Inorganic Constituents. Difference in their amounts and composition. Inherent and extraneous Ash. Distribution of mineral matter in Coal. Its bearing on the constitution and formation of Coal. Separation of Coal components. Chemical changes during incineration. Analysis of Ash. Examination by X-rays. (*Demonstration*).

LECTURE II.—Mineral matter in relation to the Mining of Coal. Cleat, partings, roof and floor. Spontaneous combustion. The Pyrites problem. Prevention of Explosions by stone-dusting. Chemical method of Coal getting. (*Demonstration*). Preparation of Coal for the market. Hand-picking, screening, dry-cleaning, sampling. Coal washing. Flotation methods. Coal drying.

LECTURE III.—Influence of mineral constituents on the utilisation of Coal. Chemical and physical behaviour in combustion process. Pan Ash cleaning. Melting point of ash. Behaviour in Gas Producers. Influence of inorganic constituents on the carbonising process. Catalysis in coking, gas making and low-temperature carbonisation. Quality of Coke. Influence on hydrogenation and total conversion of Coal into oils. The clean Coal of the future.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 23..Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. E. E. Tasker, "The Testing of large Electric Plant"
At Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. T. Carter, "The Engineer his Due and his Duty in Life."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Dr. H. Gordon Thompson, "From Yunnan-Fu to Peking along the Tibetan and Mongolian Borders."

University of London, at King's College, Strand, W.C. 6 p.m. Mr. H. Wickham Steed, "Central Europe and the War" (Lecture II); 5.30 p.m. Dr. W. T. Gordon, "Geology and Civilisation" (Survey Lecture V); 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music" (Lecture V).
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. Otaker Vocadlo, "From Bohemia to Czechoslovakia" (Lecture III).

TUESDAY, NOVEMBER 24..Anthropological Institute, at Burlington House, Piccadilly, W. 8.30 p.m. Sir Arthur Evans, "Early Nilotic Libyan and Egyptian Relations with Minoan Crete" (Huxley Memorial Lecture).

Aeronautical Engineers, Institution of, at Olympia, W. Mr. R. J. Parrott, "Training Aircraft."

Electrical Engineers, Institution of, at Hotel Metropole, Leeds. 7 p.m. Mr. T. Carter, "The Engineer his Due and his Duty in Life."

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. Oscar Brunler, "Internal Combustion Boilers."

Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Mr. J. Campbell, "Killing no Murder."

University of London, at King's College, Strand, W.C. 5.30 p.m. Miss Hilda Oakeley, "The Philosophy of Aristotle" (Lecture IV).
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "History of Russia before Peter the Great" (Lecture VII).

WEDNESDAY, NOVEMBER 25..Automobile Engineers, Institution of, at Houldsworth Hall, Manchester. 7.15 p.m. Captain R. K. Hubbard, "The Requirements of the Military Motor Vehicle."

Royal United Service Institution, Whitehall, S.W. 3 p.m. Admiral Sir E. J. W. Slade, "Oil Supplies in War."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Mr. G. F. Barwick, "The British Museum for Research Purposes"; 5.30 p.m. Dr. C. F. Sonntag, "Man's Place in Nature" (Lecture I).
At King's College, Strand, W.C. 5.30 p.m. Prof. Fernand Baldensperger, "L'Exotisme dans la littérature Française Moderne" (in French).

THURSDAY, NOVEMBER 26..Aeronautical Society, 7, Albemarle Street, W. 5.30 p.m. Mr. A. H. R. Fedden, "Installation Problems in Air-Cooled Engines."

Antiquaries, Society of, Burlington House, Piccadilly, W. 8.30 p.m.

Chemical Society, Burlington House, Piccadilly, W. 6 p.m. Prof. R. Robinson, "Recent Researches on the Structural Relationship of some Plant Products."

Central Asian Society, at Royal United Service Institution Whitehall, S.W. 5 p.m. Captain F. Kingdon, Ward, "Through the Gorge of the Tsang-Po."

Child-Study Society, at 90, Buckingham Palace Road, S.W. 6 p.m. Brig.-General R. J. Kentish, "Playing Fields for Children."

London County Council, at the Geffrye Museum, Shoreditch, E. 7.30 p.m. Mr. W. G. Raffé, "The Meaning and use of Proportion in Design."

Structural Engineers, Institution of, at Great Northern Hotel, Leeds. 6.30 p.m. Mr. E. C. Inelgrove, "Fieldwork in Central Africa."

University of London, at King's College, Strand, W.C. 5.15 p.m. Mr. E. L. Woodward, "Thomas Hobbes"; 5 p.m. Dr. C. Da Fano, "Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System" (Lecture VIII); 5.30 p.m. Mr. Marcu Beza, "The Story of the Creation and the Flood in Roumanian Folklore" (Lecture I).
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. S. Mirsky, "Russian Literature since Chekhov" (Lecture VIII).
At University College, Gower Street, W.C. 5.30 p.m. Dr. A. M. Bassani, "La figura e l'opera di Giovanni Boccaccio" (in Italian).

University of London, at Birkbeck College, Fetter Lane, E.C. 5.30 p.m. Sir Henry Slesser, "Trade Union Law" (Lecture III).

FRIDAY, NOVEMBER 27..Marine Engineers, Institute of, at Olympia, W. 6.30 p.m. Sir Fred W. Young, "Salvage Operations."

Physical Society, at Imperial College of Science, South Kensington, S.W. 5 p.m. (1) Mr. R. G. Lunnon, "Atomic Dimensions." (2) Mr. W. E. Benton, "On Edge Tones." (3) Mr. J. J. Manley, "The Spectroscopic Determination of Minute Quantities of Mercury." (4) Mr. J. J. Manley, "On the Storage of Small Quantities of Gas at Low Pressures." Demonstration of an instrument for imitating the eastward motion of bodies dropped from a great height, by Mr. G. R. Mather.

Transport, Institute of, at Midland Hotel, Manchester. 6.30 p.m. Mr. C. Travis, "The Railways of Australasia."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. C. M. Haines, "The Development of Shakespeare's Stagecraft"; 5.30 p.m. Dr. W. T. Gordon, "Geology and Civilisation" (Swiney Lecture VI).
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "Serbia and the Jugo-Slavs" (Lecture VII).

SATURDAY, NOVEMBER 28..London County Council, at the Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. Edward Lovett, "The Luck of an Old Shoe."

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FRIDAY, NOVEMBER 27th, 1925.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 30th, at 8 p.m. (Cantor Lecture.) R. LESSING, Ph.D., F.C.S., M.I.Chem.E., " Coal Ash and Clean Coal." (Lecture II.)

WEDNESDAY, DECEMBER 2nd, at 8 p.m. (Ordinary Meeting). LIEUT.-COLONEL SIR ALAN H. BURGOYNE, M.P., Companion Inst.Mech.E., M.Inst.P.T., A.Inst.A.E., " The Future of the Motor Car." COLONEL SIR THOMAS A. POLSON, K.B.E., C.M.G., will preside.

APPOINTMENT OF ASSISTANT SECRETARY.

The Council have appointed Mr. William Perry, B.A. (Oxon.), sometime Fereday Fellow of St. John's College, Oxford, and late of the Indian Civil Service, Assistant Secretary of the Society. Mr. Perry will also act as Secretary of the Indian and Dominions and Colonies Sections, in succession to the late Mr. Samuel Digby, C.I.E.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust Professor Henry E. Armstrong, F.R.S., will present to a juvenile audience " Alice in Wonderland at the Breakfast Table." He will be assisted by Alice, the March Hare, the Dormouse, the Mad Hatter, the Cook, the Duchess, and Father Christmas.

The play will be given in two acts, the first on Wednesday, January 6th, the second on Wednesday, January 13th, each day at 3 p.m.

Special tickets are required for these performances. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to tickets admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

REPRINT OF CANTOR LECTURES.

The Cantor Lectures on " The Inner Structure of Alloys," Walter Rosenhain, D.Sc., F.R.S., Superintendent of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, have been reprinted from the *Journal*, and the pamphlet (price 2s.) can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A full list of lectures which have been published separately and are still on sale can also be obtained on application.

THIRD ORDINARY MEETING.

WEDNESDAY, NOVEMBER 18th, 1925. MR. H. AVRAY TIPPING, F.S.A., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

The Hon. Mrs. Fitzalan-Howard, London.
William Moorcroft, Trentham, Staffs.

The candidates proposed on November 4th, a list of whom was published in the *Journal* of November 13th (pages 1100-01) were duly elected Fellows of the Society.

A paper on " The Furniture of Hampton Court and other Royal Palaces " was read by Mr. Ingleson C. Goodison.

The paper and discussion will be published in the *Journal* of December 4th.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

WEDNESDAY, NOVEMBER 11th, 1925.

THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T. in the Chair.

The paper read was:—

THE MODERN NOTE IN INDUSTRIAL ART.

By SIR CECIL HARCOURT-SMITH, C.V.O., LL.D.

(Late Director, Victoria and Albert Museum.)

TRUEMAN WOOD LECTURE.

The close of the great Paris Exhibition of Modern Decorative and Industrial Art makes it, I think, a fitting occasion to deal with the subject which I have chosen for this evening's lecture. For, as you are probably aware, the special feature of that Exhibition was that its scope was in theory limited to works " of modern inspiration and of genuine originality—in keeping with the demands of modern decorative and industrial art."

I doubt if there was ever a time in which the word "modern" possessed quite the same significance that it does to-day. Since the War, the old order has been in process of change, and it is not yet easy to see how, in the poet's words, God is fulfilling Himself. Nor have the arts been immune from this influence. We are, perhaps, more familiar with its manifestation in the sphere of the "fine arts," but, as Paris has shewn, it has greatly affected the decorative and industrial arts as well. Here, as elsewhere, tradition and time-honoured principles are on their trial, if not wholly ignored; and the first result of cutting the painter and venturing into uncharted seas has been a certain vagueness of direction which to the plain man is bewildering. In the absence of a clear course the old sailing directions are apt to be ignored, and even the cabin boy, if he shout loud enough, may command attention as an authority. Human nature is prone to appreciate novelty for novelty's sake, often without any inconvenient reflection as to principles or suitability: and to this cause we owe chiefly the kaleidoscopic and depressing visitation which the world of art has recently endured. New gospels succeed each other with such startling rapidity that one is reminded of the saying "you cannot count your chickens, they run about so."

On the other hand, the new movements, so far as they are sincere, and are not merely intended "pour épater les Bourgeois," must be reckoned with: and the student of art will do well to examine them closely in order to seek out the real grain buried in the chaff. We need to see not only how much of the new hot gospellers' creeds has come to stay, but what effect they have already had on the permanent fabric. If art is not to remain a frozen and unattainable ideal, but is to fulfil its function as a living influence in beautifying a grey and work-a-day world, it must at least be conscious of movement and of progress. While retaining, and jealously guarding, its conservatism, it must be alive to note, and if necessary respond to, such changes of thought or habit as are not merely bubbles on the stream of fashion. It is thus inevitable that in a healthy community the balance should swing between the traditional and the novel.

As Director for many years of the Victoria and Albert Museum, I may be suspected of having a *parti pris* in favour of tradition. I am bound to confess that when I first saw announced the scope of the Paris Exhibition, stressing the modern note to the practical exclusion of the accepted and traditional, I felt considerable misgiving. It would have been disastrous, I felt, at the present stage, when the new movements themselves, and public opinion regarding them, are equally in a state of flux, to assist at the canonisation of half-fledged ideas, some of which at least had their spiritual home in Moscow. On the other hand, I hold strongly that a Museum of Industrial Art is in a sense a Trade Institute, and that, if it is to fulfil its most useful function, its officials must keep in touch with modern ideas and set their faces against the slavish imitation of the old. We do not want to develop a breed whose

minds, as someone has put it, are composed of mental fly-paper: where everything sticks, in a more or less painful attitude. Rightly used, a treasury of past masterpieces should serve as a most valuable quarry for the independent genius of to-day, providing an inspiration, a standard, and a warning: an inspiration, which may lead him to follow along the paths which have led his predecessors to success: a standard which may deter him from identifying himself with the trivial or unworthy: and a warning not to ignore the lessons learnt by craftsmen of the past, both of avoidance and of selection.

In using the term "modern" as opposed to the traditional in art, we must, I think, be careful to apprehend the precise significance of both terms in this specific application. There are, undoubtedly numerous categories of industrial art, such as electric lighting and motor mascots for example, in which no tradition exists, for the simple reason that they have come into existence for the first time out of the new social conditions under which we live to-day. The extended use of machinery and of steel construction found the world, unfortunately, at a period when æsthetic knowledge and achievement were at a singularly low ebb: and the revival of both, such as it is, has not yet had time to adjust itself or, so to say, to catch up with the new requirements. In such directions as these, none will deny that there is not only scope but need for the "modern" note. It is when we come to the crafts of long standing, with the centuries of tradition behind them, that caution is necessary. We are the heirs of all the ages, and, it may be added nowadays, of all the nations whose products are brought to our doors by increased facilities of communication: that is to say, we have inherited the successes which have survived the test of time and distance. But it does not follow that because this or that design or decoration or process is not found in the schedule of our inheritance, it is necessarily, therefore, "modern." Without going so far as to say that there is nothing new under the sun, we may reflect that all history teaches us to regard the word "novel" as suspect. What, for instance, do we know of the failures, or even of the trial-pieces of the masters of the past? Who shall say that this or that "innovation" in art may not have been tried long ago and found wanting by craftsmen and judges fully as competent as ourselves? Unless, therefore, we avail ourselves of the experience of the past, we shall find ourselves travelling along bye-paths and short cuts which may seem attractive but will lead nowhere but into a dead end or a quagmire. The modernist, in short, must take care that his pretentions do not remind us of that useful animal the mule, which, as someone has said, while taking no pride in its ancestry, can indulge in no prospect of posterity.

My point is that, within certain limitations, the philosopher will regard, with interest, yes, but with equanimity and caution, the allurements of the so-called "modern note" in art. Further, he will reflect that in the interest of proportion and perspective he should be chary of prophesying the child's future until it is at least ten years old: up till that time the legitimate pride

of parents and nurses is apt to give one an exaggerated idea of the young hopeful's attainments. And, meanwhile, he will not hesitate, for his own private satisfaction, and undeterred by what, for short, we may call Epstein controversies, to measure it by those canons of taste which, thank goodness, are not yet dead, though sometimes they appear to be sleeping.

I have somewhat laboured this point, even at the risk, I fear, of wearying you, because recent events seem to show more and more the necessity of reverting to first principles. Not only has there been in the Press a tendency to swallow whole and unmasticated the most dazzling excesses (as well as the successes) of the Paris Exhibition, but we have recent examples in our own streets which seem to show how wide is the scope for divergence of opinion, because there is no common ground of agreement as to what is seemly and appropriate in art. I do not envy the task of the Commission of Fine Arts, of which our respected Chairman is the President; the job of brooding over chaos cannot be a light one, and one wonders what sort of a world-egg they will eventually hatch out.

It is the fashion nowadays to decry Ruskin. As a boy, I was brought up in personal contact with him and his teaching: and although it is easy now to see that his enthusiasms sometimes led him to the pitch of fanaticism, yet taken as a whole, his gospel, coming when it did, was little short of divine. I always like the anecdote of the Yorkshire bookseller whose fervent admiration of him was expressed in the words, "There was a man sent from God, and his name was John." I think it was Hazlitt who used to say "Whenever a new book comes out, I read an old one." It would possibly not be a bad plan if whenever a new memorial is set up in our streets, certain selected passages from Ruskin were read, as a kind of First Lesson, at the unveiling ceremony. Ruskin above all preached against what he called "luscious ugliness." To-day there is a positive cult of the ugly. Why? Because you cannot have τὸ καλόν, abstract beauty, without an accepted canon, or at any rate without admitting certain axioms: and if you indulge in the pleasure of abolishing the law and the prophets, you are back at the primordial: and since the aim of the primal craftsman is to attract attention and advertise himself, the excessively ugly has as much a chance of doing so as the supremely beautiful.

I suppose it is a fact—and a painful one—that we are becoming frightfully self-conscious about art. It is a pity that it is so, because instead of the thing being spontaneous or inherent like an ear for music, we too often end by producing something which is artificial and hothouse, and which has no real root in the national soil. We talk too much about it, we analyse and dissect the poor thing in order to see how it is growing or what is wrong with it: and then along comes the scientist who reduces the whole to formulæ and prescriptions, and talks learnedly about lines and planes and dimensions. I have been told by professional musicians that there is no such thing as a discord in music; and presumably therefore, one should not object to the

harmonies which America and Africa are combining to give us. And I suppose one ought to welcome what someone has called "the wide and spacious freedom from melody and rhythm" which accompanies the investment of certain modern music with "literary and mathematical charm."

After all, music is merely passing through the same phase of modernity which is affecting the other arts: one might call it the mathematical ailment. I was much struck the other day when, venturing to criticise a certain sculptured relief which shall be nameless, I met with the same answer (from a quite intelligent person) to all my objections: the composition was bastard and bad, the forms were inhuman, the whole thing was ugly and grotesque: yes, but look at the beautiful straight horizontal line which cuts the upper border of the relief. Incidentally I may remark that the Greeks hated a straight horizontal line, and they knew something. But to-day we are all for it: our modern formula is "Line upon line, here a snippet, there a snippet": never mind the significance so long as it is mathematical.

One of the things that struck my attention particularly in Paris was the tendency to what one may call triangulation in design. I do not suppose many people to-day read the "Loves of the Triangles"; but many things in the Exhibition might have served to remind a reader of that amusing parody.

I do not, of course, mean to say that triangulation in design is necessarily a bad thing. On the contrary, where it grows out of, or is appropriate to, the material or the purpose of the object ornamented, it may be most attractive. Many nations and tribes have used it successfully in their primitive or savage state; and it is quite a sound method of decorating a vase when you are restricted to scratching in the soft clay with a pointed stick. But it is not a good system to apply, for instance, to wood furniture, where sharp angles are apt to find out the weak points in your system.

I am afraid it may be thought that I am devoting my remarks too exclusively to depreciation and too little to a just estimate of the value of the modern movement in industrial art. If that is so, I must plead that circumstances, to some extent, justify this attitude. Letter after letter has appeared in the press extolling the excursions of our foreign competitors in this respect, while deriding or deploring our own conservatism. Personally, I am lost in admiration of much that I saw in Paris: the technical skill, the restless and supple inventiveness, and, above all, the *bonne volonté* with which craftsmen of all kinds seem to have combined for their own and the common good. It is plain, however, that indiscriminate and uncritical eulogy is neither a compliment to the recipient nor useful to the world at large. I propose to devote a few moments to a detailed consideration of some of the Paris exhibits in the light in which they appeared to me to merit either approval or criticism. It would obviously be impossible within the limits of this paper to deal even briefly with every one of the numerous categories concerned: I am, therefore,

confining myself to some of the more typical examples which illustrate my point.

At the outset, I should like to remind you that all categories of industrial art are not on the same footing as regards susceptibility to natural development or fortuitous changes, such as result from alteration of social conditions or passing fashion. A distinction must be drawn, for instance, between those which are more costly or more durable, and those which from their nature or condition are more sensitive to changes of fashion or more liable to destruction. As examples marking each end, so to speak, of the scale, we may take, on the one hand, furniture and the finer class of metalwork, and on the other, textile fabrics, especially such as are used for dress. It is obvious that a class of goods such as textiles, which is subject to fairly continuous demand, and of which the range of design requires constant renewal, will absorb new ideas with greater ease, and probably with a larger measure of success. It employs a larger body of designers, and under the quickening influence of competition it is peculiarly alert to observe, and, if necessary, to absorb the changes of fashion as they occur, or even to initiate such changes. Moreover, the case of costume and furnishing fabrics is peculiar in this respect, that they are subject to two more or less independent impulses of fashion: on the one hand there is the manufacturer's designer, who, while maintaining the necessarily broader outlook of his position, is to some extent dependent upon the dress and furnishing designer, who in his turn maintains a closer touch with the buying public. The latter class of designer may even occasionally initiate so strong an independent movement as to revolutionise the ideas of his opposite number. I remember an instance of this which occurred in connexion with the Rheims tapestries. These tapestries, you will remember, were for safety withdrawn from Rheims Cathedral during the war: we had the advantage—by the courtesy of the French Government—of seeing some of them at the Victoria and Albert Museum. Before their return to Rheims, they were exhibited for a short time in Paris at the Petit Salon: and the Director of that Institution, M. Lapauze, himself told me that during their visit to Paris he took the opportunity of having a private view, to which were invited some two thousand of the principal *modistes*. The effect was, that within a month the whole range of Paris fashions had undergone a transformation, which was, M. Lapauze believed, directly due to the new ideas inspired by the Rheims tapestries.

In these circumstances, it is only natural to find that one of the most striking features of the Paris Exhibition is the magnificent display of fabrics, which illustrate the amazing wealth of modern design and technique available in this category. While the Textile Section is, of course, dominated by the exhibits of the Lyons weaving industry, there are also beautiful products from other parts of France and from Italy. It is a satisfaction, moreover, to note that English manufactures, notably those of Messrs. Warner and Co.,

fully hold their own in this exacting competition. As regards modernist ideas of technique and design, one is struck with the increasing use of metal filament, resulting often in very pleasing and novel effects, and also by the tendency to enormous size in the detail of ornamental design. In some cases a single repeat is from three to four yards in length, and in one case at least a rose in black and gold metal is fully eighteen inches in diameter. This peculiarity is found in dress as well as in the merely decorative fabrics, and it is difficult to understand how they can be intended as applicable to common use. In any case, their costliness will probably place them beyond the reach of any but the richest purchaser. On the whole, the modern note, both in design and colouring, as seen in these fabrics, is decidedly pleasing. It is only here and there that one comes across a futurist design in staring tints which affects one like a crazy nightmare.

In the matter of carpets and rugs, as shown in Paris, British manufacturers seem to have much to learn. Our market has been so long dominated by the demand for Persian, Turkish and Chinese examples, and imitations of these, that there would appear to be little incentive to independent national design. I was greatly struck by the variety of designs, mostly quite modern in character and many very pleasing, which were to be seen, in the Swedish Exhibit for instance, and especially in the French section. Room after room in this section was provided with a carpet which had apparently been specially woven, so that the design and colouring should harmonise admirably with those prevailing in the particular room in which it was shown. No doubt such an effort as this involves a counsel of perfection, to be attained only with difficulty and considerable expense, but I think it conveys a lesson which our manufacturers would do well to take seriously to heart.

In the furniture shown at the Exhibition, I must confess to a feeling of disappointment. An article has appeared in the Press on this subject, by Mr. Hamilton Smith, an authority both on the commercial and artistic side of the subject, who, in giving the French furniture (as distinct from the British) unstinted praise, spoke of the "superb audacity, which flouts all the canons of cabinet making": he goes on to speak of the "sense of restraint and instinctive feeling for fine proportion." I am loath to disagree with a well-known authority, but while I admit that the old skill in workmanship remains, and the admirable French instinct for colour effect is displayed in the selection from the amazing range of materials now available, I cannot follow him in his panegyric. The question of proportion is too controversial to deal with here: I may say, however, that personally I regard the want of it as the chief defect of most modern as compared with old furniture: that, and the restraint which limits decoration in general to what is relevant and is subjective to the form, the purpose and the material of the object decorated.

Without wishing to appear insular, I may say that I am convinced that the best furniture for domestic use that has ever been made is the English

furniture of the seventeenth and eighteenth centuries. It is not a question of atavism, nor yet a prejudice in favour of what Sir Lawrence Weaver calls the Jacobean umbrella-stand; but I am still waiting to see something produced to-day which offers a happier combination of the practical with the beautiful. I sometimes wonder whether our pre-eminence in this matter is not partly due to the fact that we of all nations best understand the word "home." I was interested to discover in the Czecho-Slovak pavilion an exhibit by a firm who claimed to be "manufacturers of English furniture": and Czecho-Slovakia has a fine tradition in furniture of its own.

Certainly French furnishing, beautiful as in many respects it is, is often lacking in the sense of intimacy and comfort. Much of their furniture is either Gargantuan or flimsy: and, in keeping with the tendency towards the colossal, there is an increasing inclination to use marble for the decoration of house rooms: not only for the walls, but also for the actual furniture: we find thick marble slabs, for instance, resting on metal or ponderous wooden supports, employed as commodes or even as dining tables, with a result which conveys an impression of costly discomfort.

On the other hand, in the charming art of *ferronerie*, decorative ironwork, we have much to learn from the French. The works of Brandt especially, which are shown individually throughout the Exhibition and collectively in an admirable room designed throughout by him in the Galérie des Invalides, exhibit a mastery of design and execution in sympathy with the qualities of his material, its malleability and ductility, which place him as a master on a level with that attained in glass by his great compatriot Lalique. If one may be permitted a small criticism, it is that he is apt to forget that a scroll of flat metal is an unsuitable form to use as a support, particularly of so heavy a material as marble.

In the art of ceramics, those who look for new and startling developments except on the technical and scientific side, are, I believe, doomed to disappointment. It would seem that the nations of antiquity, from the Greeks and the Chinese downward, have long ago exhausted the range of suitable forms. If "novelty" is to be sought, it must be found either in decoration or in technical processes. The new decorative effects are obtained mainly by the employment of designs which are either an adaptation of the primitive or are borrowed from other materials: and in either case the result is seldom satisfactory. It is a curious fact that, as the result of the Exhibition, awards were given, for instance, to the products of the Copenhagen factory which have been on the market for many years, and to British and Swedish examples which, charming in themselves, belong to the traditional rather than the modernist style. The advance of scientific knowledge of glazes and firing has produced a quality of glazing which is sometimes almost dazzling in effect. The result in these pieces is that it is often impossible to see clearly the outline of form, to say nothing of the decoration. The conditions are, in fact, very much

the same as those of a piece of highly polished silver, and I am inclined to think that potters have not yet succeeded in adjusting their ideas both of form and decoration to the new conditions.

I should have liked, if time allowed, to go into some of the other categories in which the Paris Exhibition affords valuable lessons: stained glass and the art of the book, for instance, in both of which our own productions suffer nothing by comparison with our neighbours, but rather the reverse. There is, however, one point on which before closing, I should like to touch, and that is the commercial aspect of industrial art as shown in Paris.

The bulk of the more important objects shown appear to have been executed without the slightest regard to the expense of production and, therefore, to saleability. We have been told that they are intended for the *grandes cocottes*, or for the *richissime* of North and South America. It is rather disheartening for those of us who have been trying to combat the view—more prevalent perhaps, in England than in France—that artistic quality is necessarily expensive. The British Institute of Industrial Art and the Design and Industries Association have both been active in forming exhibitions of good things which can be bought for comparatively small sums; and I should like to think that in any further international exhibition a part at least to it might be so devised as to inculcate this lesson.

The limitation of my subject has debarred me from touching on a topic which, though not strictly falling within its purview, is of the greatest importance and interest; that is, the relationship between the designer and the producer. The weakening, if not the severance, of tradition both as regards the theory and the practice of art in relation to industry was one of the results of the great industrial revolution in which the new developments of science changed the whole conditions of commerce. It has long been recognised that scientific research is a vital part of the national equipment, if our trade and commerce are to hold their own. Unfortunately the advance of science in this respect has not been accompanied by corresponding recognition of the necessity of art to commerce. The term art in this connection does not, of course, mean statues or easel pictures, but has the broader significance of quality, as touching everything that concerns our daily life. As William Morris said, I think, art is "the expression of the workman's pleasure in his work."

One of the results of the industrial revolution has been the changed relationship which has been brought about between the design and the actual production. In industries which are subject to mechanical multiplication, the designer is not always able to follow his work to the same extent as formerly into its ultimate stages of production, and a tendency has grown up towards the purchase rather than the creation of designs; and on the other hand, to substitute for the manufacturer's designer a class whose duty it is to adapt the designs so acquired to the technical requirements of the production. When we see, as for instance in the case of textiles, large quantities of designs being

imported from centres abroad such as Paris and Lyons, it is evident that all is not well with the industry, and that British tradition must sooner or later become non-existent.

The seriousness of this case has been admirably stated in an essay by Sir Hubert Llewellyn Smith, "The Economic Laws of Art Production," published in 1924. Sir Hubert refers to the various problems concerning modern industrial art, such as the training of industrial designers, the relation of the producer to the ultimate consumer, and so forth, and pleads for organised study in them in close connection with the conditions of each particular trade and industry. Such systematic study, so far as Government organisation is concerned, has hitherto been almost exclusively confined to the side of science. The Department of Scientific and Industrial Research co-ordinates the work of the various research organisations and others to increase the efficiency of industry by the advancement and diffusion of knowledge of scientific principles; but in the case of Industrial art there is no such organisation dealing authoritatively with the matter and commanding the necessary funds. Such organisations exist in other countries. In Germany, for instance, we have the Werkbund; in Sweden a committee consisting of artist, technician, manufacturer and distributor, which judges new domestic products in the light of their quality from these different aspects, and advises as to their saleability accordingly. In New York an enquiry has taken place into the whole question of design in relation to industry and the results have been published in book form. In this country, it is true, something has been done by way of isolated and individual effort. The Royal Society of Arts has made a most welcome move in the encouragement of industrial design by the institution of their competitions in design affecting certain trades, of which the results have been shown at the Victoria and Albert Museum; this undertaking has, I believe, been carried out with the co-operation and sympathy of the manufacturers. The British Institute of Industrial Art, which has for one of its objects the furtherance of research, was started with a subvention from Government funds, but has been obliged since this supply failed, to limit its useful activities within a somewhat restricted area.

What is really needed is that Government should recognise its responsibilities in the matter, taking to heart the seriousness and pressing urgency of the case if British trade is to maintain its position. If the time is not ripe, or the occasion unsuitable, for establishing a Department of Industrial Art Research, something might at least be done to save the situation by a State subvention of the existing organisations, before it is too late.

Finally, to revert once more to the main subject of my remarks, it may be that I have said more than was necessary or fitting to an audience such as this in pleading that our attitude of welcome to the modern movement should be tempered with some reserve. But I believe that such pleading is not altogether unnecessary. If any of you suppose however, that the

phase through which we are passing is altogether unprecedented, I would refer him to the concluding paragraph of the Seven Lamps of Architecture :— Ruskin says, "There is something ominous in the light which has enabled us to look back with disdain upon the ages among whose lovely vestiges we have been wandering. I could smile when I hear the hopeful exultation of many, at the new reach of worldly science, and vigour of worldly effort; as if we were again at the beginning of days. There is thunder on the horizon as well as dawn."

DISCUSSION.

THE CHAIRMAN said he was sure the audience would all share the pleasure which he himself felt for the admirable address which had just been delivered. On the whole he was glad that Sir Cecil had not illustrated his argument by lantern slides. It was much better, in dealing with a large subject in so philosophic a manner, with so broad an outlook upon the past, and with so wise a forecast of the future, that Sir Cecil should have dealt in abstractions rather than illustrate his argument by the particular examples.

Sir Cecil had told many truths which once perhaps were truisms, but which were now re-emerging as paradoxes, and personally he was one of those old-fashioned enough to believe that from time to time the truth should never be considered unwelcome. Nowadays, for a variety of reasons not always easily defined, our minds were more sympathetic and more readily attuned to what Sir Cecil called the modern note than for a good many years past. That temperament had been prevalent in this country, at any rate, for 40 or 50 years, and it was from this country that all those movements on the Continent unquestionably drew their inspiration, so that we, as was our custom in this country, having started a great, and very often, noble movement, fell behind in the second lap of the race, but in the last, and in the most important lap, made up our lost ground. It was not blameworthy, therefore, that there still should survive in this country a body of opinion which while appreciating novelty, did not allow itself to go too far, but permitted itself some of the natural timidity of mankind in facing new, and possibly revolutionary developments—a very old sentiment in the human breast which the Greeks called misoneism.

We had it in this country to-day, and in some ways it might not be without service. Of course, it could be very readily abused. The canon of art which sterilised pretty nearly every art in the whole of Europe for 500 years, and in Eastern Europe in the orthodox Church for 1,500 years, and which still prevailed to-day, was so powerful as to limit every vestige of activity or research. It had debased the artist into a mere copyist, and to-day had killed an art which might, but for that canon, be developed into something far more vital than the low class of standardisation which now governed it. But when we prided ourselves on our originality we had to be careful that we did not set up a new canon of art ourselves, namely the canon of originality—an art, in other words, which must be original if it was to be worthy of the name of art at all. Sometimes it took the form of eccentricity. He had not noticed the marble dining-room tables in the Paris Exhibition, but he could imagine nothing more eccentric. These who had designed that dining room table surely could have had no knowledge of domestic affairs, when, for instance, the dining room table had to be moved on a wet day in order to

let the children play. That in itself was a fatal and unanswerable objection to that form of eccentricity, which, quite apart from its ridiculous cost, destroyed the value of the object, of the work of art, of the piece of furniture, of whatever the actual object might be to which that class of mind directed itself.

Then Sir Cecil had used a phrase about the "cult of ugliness." He supposed that ugliness did exist. We were told very often that it did not. Whether it really were ugly or not was immaterial so long as it did seem to one to be ugly. Undoubtedly some people preferred to make something which seemed ugly rather than to make something which they would call academic prettiness, or anæmic or flaccid and meaningless. But personally, he wondered why, what was termed the cult of ugliness (however the term "ugly" might be defined) should exist. He wondered, too, sometimes how far the critic was responsible—not the producer, but the critic. The critic was a very curious person. He was so afraid nowadays of being called reactionary that he would smother with praise, often couched in wholly unintelligible terms, a work of art which he knew was not a work of art, but which he dared not criticise as he would do if it were a portrait of himself or a table for his own dining room, simply because he dared not let his fellow critics call him reactionary. That was really true. Critics did not mind what the ordinary person or what the artist or what the newspaper editor called them; their fellow critics were the men from whom the term "reactionary" was eternal damnation. Personally he thought our critics ought to be a little more courageous. They ought not to be afraid, as too many of them were, of saying unpleasant things about works of art which they were professionally obliged to criticise. If one went through one of those criticisms of a novel or a building or a painting, one would very often find in 40 or 50 lines more words expressing the various synonyms of the word "genius" than one would find in a famous book describing some great author or poet. In other words, the praise was so extravagant that one might almost be defied to take up a dictionary of synonyms and find one word of encomium which had not been used; but it was true.

He supposed that certain rules could be laid down, and by those rules a rough-and-ready test could be applied to some of these new movements in high art, fine art, and what was called industrial art. One of those rules, which would have been a truism 50 years ago, but which was a paradox to-day, was, in his own opinion, to say that a work of art must perform its function. The other day he had seen a portrait of a cousin of his. It was on a screen. His cousin was a musician, and a good deal of the screen was occupied by violins, drums and concertinas. The nose was on one wing of the screen and an eye was on the next wing but one. That was a portrait, and the victim's wife admired it very much. To his own mind it was a work of art which was not performing its function. The function of a portrait was to tell the sitter's son, or his grandson, or his sweetheart what he was like, less or more, but it ought to be more rather than less, and any portrait such as he had just described—and there were plenty which conformed to that description—was a dishonest work of art. It might be called an arrangement or a screen—but not a portrait, because a portrait it was not.

Then, personally, he liked a chair to be an artistic chair, but he wished it to be a chair in which he could sit with dignity and comfort. One could have walked round and round the Paris Exhibition and could have seen chair after chair in which no self-respecting man or woman could sit for more than five minutes. The element of utility in industrial art must not be ignored. One notable thing about the furniture and industrial art section of the Paris Exhibition (he was not talking about the British Section, which had been very ridiculously maligned) was that all

the articles were designed for an Exhibition or music hall, and none seemed designed for the home. Nowadays we had to think about our homes; we wanted the art to be in the home, and not only in music halls or hotels. It had been quite exceptional to find anything in the Paris Exhibition, in the foreign sections, which would have been suitable for the ordinary home—in point of scale he meant—of the average British or French citizen. Finally the cost of those things was grotesque and ridiculous. In all those things—in scale, utility, in appropriateness—in other words, in honesty, and finally in cost, he believed this country could give real lessons to foreign masters, whatever the critics might say. Especially was that the fact in regard to the quality of material. We were often told how wrong it was that old masters should fetch thousands and thousands of pounds, while clever struggling artists here or elsewhere were finding it difficult to make a living. One of the reasons for that was that the buying public had got a profound distrust of the durability of the paint and canvas of to-day. When Sargent's Exhibition was opened in two or three months' time in London, one would find that his pictures, 30 or 40 years old, were often cracked right across, giving almost the impression of a cobweb. There were lots of people who would prefer to buy modern works of art, but who hesitate to do so because of the risk of decay. Quality of material as well as of workmanship were canons which ought to be laid down, and about which we ought to take lessons from the Victoria and Albert Museum. It was a sad thing to think that our paintings were perishing, that our dyes were fugitive and that our wood was too often not durable. Sir Cecil had referred to a bold phrase about "a superb audacity which flouted all the canons of cabinet making." Let those canons be flouted as much as one liked in design, but for Heaven's sake let our material be good!

He was one of those—and very few there were—who believed that if we in this country only took care to learn our own lessons the future lay at our feet. He believed that we in this country were on the right lines. We still preserved, in spite of all our old-fashionedness, a certain sense of right and wrong and practical which, in the long run, were the ruling and dominant notes. We were still in a state of transition, but he hoped we should avoid being too doctrinaire in our audacity. If we kept our independence, and perhaps a due measure of insularity, he, for one, could look upon the future with an assured hope.

Lord Askwith, K.C.B., K.C., D.C.L., said that Sir Cecil Harcourt-Smith and Lord Crawford, both past-masters in knowledge of art and of criticism, had given the audience very many interesting things to think about and points which they would no doubt be able to consider further when they had the Journal before them. He could only allude at the moment to one or two points which occurred to him as developing or confirming what those gentlemen had said. He could not exactly follow Lord Crawford's point about the picture of his cousin not having fulfilled its function when the nose was on one wing of the screen and an eye upon another, because Lord Crawford had admitted that the picture had pleased the gentleman's wife, and if so it had at least fulfilled one function! He did most thoroughly agree, however, with Lord Crawford's most important criticism with regard to the material used in artistic works and of the necessity of the quality being looked after.

Sir Cecil had mentioned that there had come upon the world electric lighting and motor mascots—cases where no tradition existed—and he had also referred to the extended use of machinery and of steel construction coming at a time when, unfortunately, æsthetic knowledge and achievement were at a low ebb; and Sir

Cecil had advised that it was necessary to catch up with the new requirements. That raised a somewhat interesting point. When a new thing like electric lighting came in, the first necessity was to get the ordinary person who was going to use it to be prepared to see something that he was not accustomed to, and if possible to adapt some of the things which he might have in his house to the use of that new thing. So it was with electric lighting, particularly in the house. There had been copied the candles and the globes, and more lately the chandeliers of the old period; but novel methods for a long time had not come in. It had been exactly the same when railways had been introduced. The idea had been that there was to be a truck running upon a steel rail and that a coach or carriage should be on the top of it. In old pictures one might see that a gentleman would drive his carriage and pair to the station and put that carraige upon a truck to be rolled to London along steel rails. The keeping up with new things or the invention of new things was not perhaps sufficiently rapid, but it had always appeared to him that if one looked at past history one would find various periods of time when either industrial development, mechanical or otherwise, had been ahead of art, or when art had been ahead of industrial development, and they were always trying to meet together or to race together. He should have thought that at the period of the Renaissance art suddenly had gone far ahead of the mechanical opportunities of that time; and he thought that within the period of the last hundred years the reverse process had taken place and that probably art had not caught up mechanical inventions. Overtures had been made, in a sense. Turner had painted some wonderful pictures showing the artistic side of mechanical inventions, of great ships and other things. Brangwyn, in more recent days, had made an attempt to do the same thing, and it was to the credit of great cities like Liverpool and Manchester that they had tried to embellish their public buildings with works illustrating the Manchester Ship Canal or the beauty of labour. But even if that had been happening, then came the war, and with it a vast speeding up of mechanical enterprise and of invention directed towards mechanics, and, further, no time for the development of art in the sense of having opportunity at that period of time to study it, and, further, the calling away of many young men, who were devoted to art, to other services. Therefore there was now rather an excess on the mechanical side as against the artistic, and a feverish effort of the artistic in trying to catch up. We went so fast nowadays that it was difficult to say which would win or when they would get even again. Changes were so rapid. Only that morning he had gone to see the new War Museum opened in Imperial Institute Road. Much of it already seemed quite old and obsolete. A few days since there had been opened an Exhibition of Pictures at the Royal Academy which had been collected from all portions of Europe. No doubt it was of value for people to see what other countries were doing so that they should not be too insular. It was difficult to know what the impression on the mind of most people would be of that Exhibition, but it at least showed that the artists of other countries did not intend to put upon the human form such a quantity of drapery as was customary in this country. Still, there was the seeking after something new, and it showed to the people of this country what other nations were doing—and, of course, there must necessarily always be a difference between countries. The lessons to be drawn from other countries were no doubt extremely valuable, and the attention which was now being directed to them on all sides by criticism, by artistic journals, by Exhibitions, by conversations between artists of all countries, was likely to lead to a speeding up of artistic development and, he hoped, to its application to industrial designs which might have very notable results in the future.

Mr. Hamilton Smith said with regard to his article which had appeared in the newspaper, if Sir Cecil, after reading the first paragraph, had gone on to read the last paragraph he would have found that so far from the article being a panegyric of French furniture it was a passionate panegyric of the work of the English craftsmen. Incidentally, the whole article expressed the desire that nobody in England should be tempted for one moment to copy the French furniture. What some did earnestly wish to see copied was that attitude on the part of so many different factors in the making of works of art (by which he meant more particularly what was called industrial art) as against the apathy that was to be found in England. If he might venture on a small criticism of the paper, it was that, while in the last paragraphs of his paper Sir Cecil remarked that in our attitude to modern art we did not vastly differ from the ages that had gone before, he did not think that Sir Cecil stressed nearly enough the fact that, in every age, what was immediately going to be done in the future was disliked, and must necessarily be disliked, and what had been done in the immediate past was applauded; but the peculiar difference between this age and nearly every age which had gone before was that we worshipped the art of a certain time past—say a hundred years and upwards—whereas in almost every other age in the world's history mankind had been proud of the work which had just recently been accomplished, and had utterly scorned the work which their remoter predecessors had done.

He would agree that the 18th century marked the high water mark so far accomplished in English furniture, but there was always a higher water mark possible above the existing high water mark, and so long as we were content with the old high water mark there was no earthly possibility of arriving at a higher one. It seemed to him that there was an entirely different sensation when one looked at the modern French industrial art from that felt when one looked at English industrial art. If one was going to light an electric lamp it was necessary that a certain circuit should be completed; when that was completed the result was the glow in the filament. It seemed to him that whether one liked or disliked the particular electric light fitting—the lamp or the shade, as it were—which one found in France, still there was an unmistakable feeling that a circuit had been completed, that something vital had happened, that a real current was going through the whole thing. In England, on the contrary, particularly in the furniture trade, he did not find the slightest sense of any current moving; the circuit had not been completed; there was no glow of inspiration; there was no live vital art at all. There were exquisite copies of old things, but there was in the trade very little, if anything, to be found in the way of living design suitable for present-day needs. What he thought was the most pressing problem before us as Englishmen, whether as lovers of art or as business men, manufacturers or retailers, was to find what was that secret in France which put the public, the manufacturer, the retailer, the designer and the craftsman *en rapport*, so that they combined together to produce something which was a fine and vital thing. In England he found no such co-operation, and he found no such results.

Mr. Harold Stabler supported what the last speaker had said about the co-operation which he found existing in France, and which seemed to be entirely wanting in this country. Personally he had come back from the Paris Exhibition feeling that the French designers and craftsmen were having a great opportunity offered to them; they must be living in an earthly paradise of opportunity. That could not be said with regard to this country. He had not seen one single good poster in Paris, although the French could do posters very well; and he had come

to the conclusion that the decorative artists in France—the designers—had, during the last two years or so, been occupied on the more serious things of life. He had also felt about the English side of that matter that we had a great many really good designers designing for advertisements, and he had asked himself the question, would not our business men do better if they employed those artists more in improving their wares and goods rather than employing them on posters to advertise those goods? It seemed to him that it would be better if the energies of the artist were put into improving the æsthetic merits of the goods by introducing "The Modern Note," and then leave the goods themselves to be sold more on their merits.

On the motion of the Chairman, a hearty vote of thanks was accorded to Sir Cecil for his lecture.

Sir Cecil Harcourt-Smith, in reply, said he had read most carefully the whole of Mr. Hamilton Smith's article, and entirely appreciated what he said in the latter part of that article. The point he had particularly wished to call attention to was the phrase that he had quoted in the paper, which was all right as far as Mr. Hamilton Smith and even himself were concerned, but which might very easily have been misunderstood by those who were not well versed in the matter.

MEETINGS OF THE SOCIETY UP TO CHRISTMAS.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock (unless otherwise announced) :—

December 2.—Lieut.-Colonel Sir Alan H. Burgoyne, M.P., A.M.Inst.A.E., "The Future of the Motor Car." Colonel Sir Thomas A. Polson, K.B.E., C.M.G., will preside.

December 9.—At 4.30 p.m.—(Joint Meeting of the Indian and Dominions and Colonies Sections.)—A paper on "The Imperial College of Tropical Agriculture," by H. Martin Leake, M.A., Sc.D., F.L.S., Director of the College, will, in the absence of the Author, be read by Arthur William Hill, Sc.D., F.R.S., Director, Royal Botanic Gardens, Kew. The Rt. Hon. L. S. Amery, M.P., Secretary of State for the Colonies, will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock.

R. Lessing, Ph.D., F.C.S., M.I.Chem.E., "Coal Ash and Clean Coal." Three Lectures. November 23, 30, and December 7.

Lecture II.—Mineral matter in relation to the Mining of Coal. Cleat, partings, roof and floor. Spontaneous combustion. The Pyrites problem. Prevention of Explosions by stone-dusting. Chemical method of Coal getting. (*Demonstration*). Preparation of Coal for the market. Hand-picking, screening, dry-cleaning, sampling. Coal washing. Flotation methods. Coal drying.

Lecture III.—Influence of mineral constituents on the utilisation of Coal. Chemical and physical behaviour in combustion process. Pan Ash cleaning. Melting point of ash. Behaviour in Gas Producers. Influence of inorganic constituents on the carbonising process. Catalysis in coking gas making and low-temperature carbonisation. Quality of Coke. Influence on hydrogenation and total conversion of Coal into oils. The clean Coal of the future.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 30—University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. G. Wallas, "Bentham as Political Inventor." (Creighton Lecture); 5.30 p.m, Dr. W. T. Gordon, "Geology and Civilisation." (Swiney Lecture VII.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. Otakar Vocadlo, "From Bohemia to Czechoslovakia." (Lecture IV.)
At University College, Gower Street, W.C. 4.30 p.m. Prof. Yandell Henderson, "The Efficiency of the Heart and its Measurement." (Lecture I.)

Electrical Engineers, Institution of, at the South Wales Institute of Engineers, Cardiff. 6 p.m. Mr. J. H. Thomas, "Switchgear Developments during the past Twenty Years."

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m. D. Houseman "Some Notes on the changes made by the new Law of Property Acts with special reference to Life Assurance practice."

TUESDAY, DECEMBER 1..Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7 p.m. Captain R. K. Hubbard, "The Requirements of the Military Motor Vehicle."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. A. Reed, "Trafford Wharf Reconstruction at the Manchester Docks."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester, 7 p.m. Mr. T. Carter, "The Engineer: His Due and His Duty in Life."

Marine Engineers, Institute of, at Olympia, W. 8 p.m. Mr. A. C. Hardy, "Motor Ship Progress in 1925."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Dr. M. Cook, "The Solidification of Metals."

Metals, Institute of, at Chamber of Commerce, Birmingham. 7 p.m. Discussion on "The Production of Sound Ingots."

Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Comm. Prof. Dr. Pasquale Romeo, "The So-called Common Cold."

Anthropological Institute, 52, Upper Bedford Place, W.C. 8.15 p.m. M. Z. le Rouzic, "Les Monuments Megalithiques du Morbihan; leur Définition, leur Destination et leur Age d'après les dernières Découvertes aux Environs de Carnac."

University of London, at University College, Gower Street, W.C. 4.30 p.m Prof. Yandell Henderson "The Efficiency of the Heart and its Measurement" (Lecture II.)
At King's College, Strand W.C. 5.30 p.m. Miss Hilda D. Oakeley, "The Philosophy of Aristotle." (Lecture V)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "History of Russia before Peter the Great."

WEDNESDAY, DECEMBER 2..Civil Engineers Institution of, Great George Street, S.W. 6 p.m. Mr. H. F Molony "Escalators on the Central London Railway."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. H. A. Thomas, "The Performance of Amplifiers."
At the University, Edmund Street, Birmingham. 7 p.m. Prof. S. P. Smith, "An All-Electric House."

Entomological Society, 41, Queen's Gate, S.W. 8 p.m.

Heating and Ventilating Engineers, Institution of, at Olympia, W. 7.30 p.m. Mr. J. E. Boaz, "The Requirements of Ablutionary and Recreative Bathing Establishments as Affecting the Heating and Ventilating Engineer."

Sanitary Engineers, Institution of, at Olympia, W. 6 p.m. Mr. G. M. Flood, "Garbage Reduction Processes."

Public Analysts, Society of, Burlington House, Piccadilly, W. 8 p.m. Dr. J. S. Owens, "Measuring the Smoke Pollution of City Air." Dr. Oscar L. Brady and Gladys V. Elsmie, "2 : 4—Dinitrophenylhydrazine as a Reagent for Aldehydes and Ketones." Mr. Gunner Jorgensen, "The Determination of Phosphoric Acid as Magnesium Ammonium Phosphate." Mr. C. H. Thomson, "On the Effect of 'Blowing' on the Composition of Certain Fatty Oils."

University of London, at the School of Oriental Studies, Finsbury Circus, E.C. 5 p.m. Rev. W. S. Page, "The Early Days of Rabindranath Tagore."
At University College, Gower Street, W.C. 5.30 p.m. Dr. C. F. Sonntag, "Man's Place in Nature." (Lecture II.)

THURSDAY, DECEMBER 3..Aeronautical Society, 7, Albemarle Street, W. 5.30 p.m. Prof. B. Melvill Jones, "The Control of Stalled Aeroplanes."

Antiquaries, Society of, Burlington House, Piccadilly. W. 8.30 p.m.

Chemical Society, Burlington House, Piccadilly, W. 8 p.m. Messrs. B. Lewis and E. K. Rideal, "On the Budde Effect in Bromine. Part I. The Photo-active Constituent in Wet Bromine." "On the Budde Effect in Bromine. Part II. The Kinetics of the Reaction and the Light Absorption of Wet and Dry Bromine." Messrs. R. Gane and C. K. Ingold, "The Influence of Carbon Rings in the Velocity of Reactions Involving their Side-chains. Part I. The Hydrolysis of Cyclic and Open-chain Malonic Esters." Messrs. H. V. A. Briscoe, P. L. Robinson, and G. E. Stephenson, "The Density of Boric Oxide Glass and the Suspected variation in the Atomic Weight of Boron."

Electrical Engineers, Savoy Place, Victoria Embankment W.C. 6 p.m. Prof. S. P. Smith, "An All-Electric House."

Geological Society, Burlington House, Piccadilly, W. 5.30 p.m.

Linnean Society, Burlington House, Piccadilly, W. 5 p.m.

Royal Society, Burlington House, Piccadilly, W. 4.30 p.m.

University of London, at King's College, Strand, W.C. 5.15 p.m. Miss A. E. Levett, "James Harrington"; 5 p.m, Dr. Da Fano, "Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System." (Lecture IX.); 5.30 p.m, Marcu Beza, "The Story of the Creation and the Flood in Roumanian Folklore." (Lecture II.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. S. Mirsky, "Russian Literature since Chekhov." (Lecture IX.)
At the School of Oriental Studies, Finsbury Circus, E.C. 4 p.m. Mr. E. H. Hunt, "The Rock Temples of Ellora and Ajanta."

London County Council, at the Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. C. A. Hindley, "The Development of the Piano Case."

FRIDAY, DECEMBER 4..Philological Society, at University College, Gower Street, W.C. 8 p.m. Mr. H. T. Wharton, "Wigeon, etc."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Dr. W. D. Lang, "The Submerged Forest at the mouth of the River Char and the History of that River"; S. W. Wooldridge, "Some Phases in the Structural Evolution of the London Basin."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. W. T. Gordon, "Geology and Civilisation." (Swiney Lecture VIII.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "Serbia and the Jugo Slavs." (Lecture VIII.)

SATURDAY, DECEMBER 5..London County Council, at the Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "Travel and Transport in Ancient Egypt."

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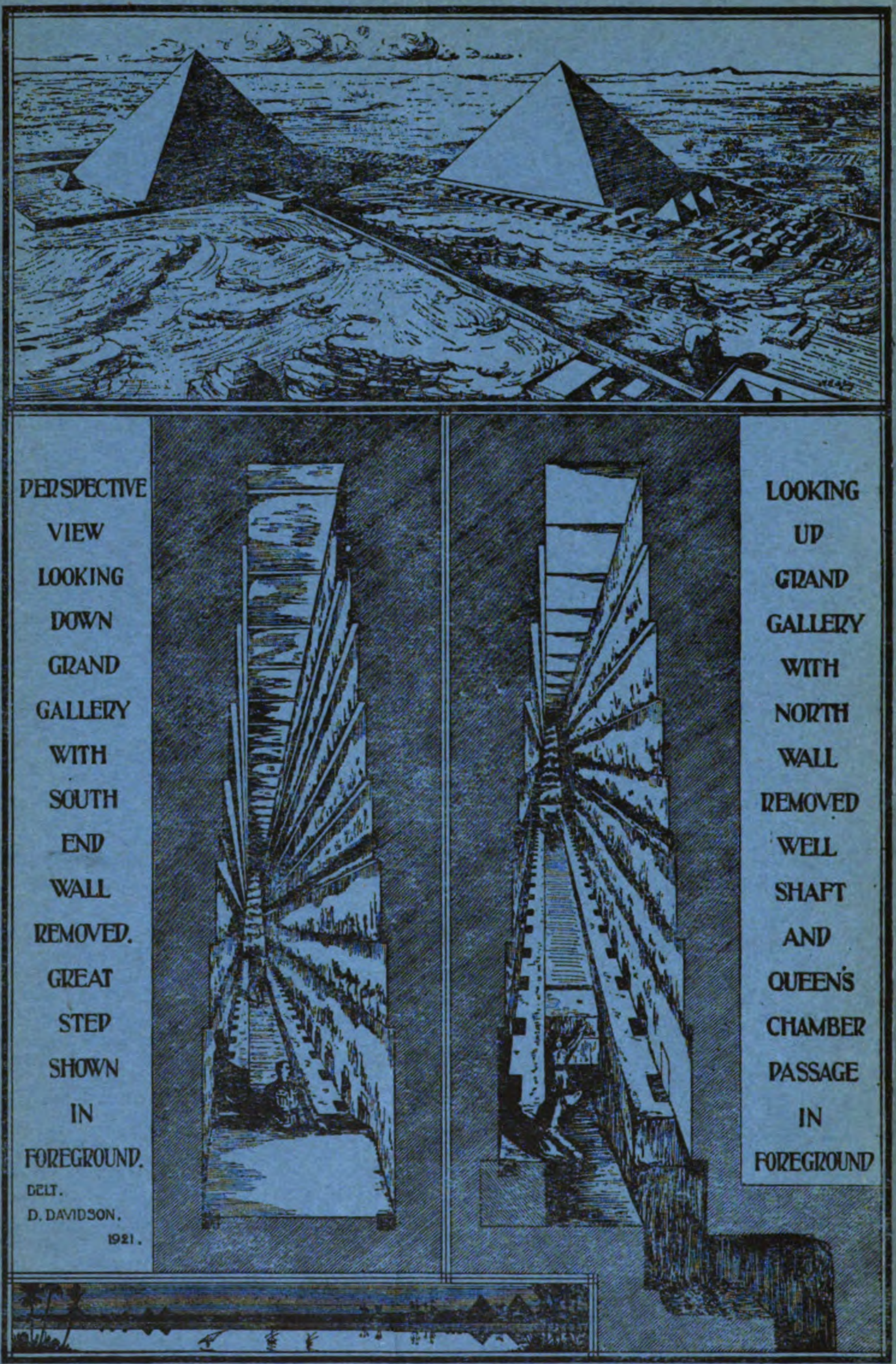

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THE GREAT PYRAMID: ITS DIVINE MESSAGE.

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FRIDAY, DECEMBER 4th, 1925.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 7th, at 8 p.m. (Cantor Lecture). R. LESSING, Ph.D., F.C.S., M.I.Chem.E., "Coal Ash and Clean Coal." (Lecture III).

WEDNESDAY, DECEMBER 9th, at 4.30 p.m. (Joint Meeting of the Indian and Dominions and Colonies Sections).—A paper on "The Imperial College of Tropical Agriculture," by H. MARTIN LEAKE, M.A., Sc.D., F.L.S., Director of the College, will, in the absence of the Author, be read by ARTHUR WILLIAM HILL, Sc.D., F.R.S., Director, Royal Botanic Gardens, Kew. The HON. W. ORMSBY-GORE, M.P., Under-Secretary of State for the Colonies, will preside.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust Professor Henry E. Armstrong, F.R.S., will present to a juvenile audience "Alice in Wonderland at the Breakfast Table." He will be assisted by Alice, the March Hare, the Dormouse, the Mad Hatter, the Cook, the Duchess, and Father Christmas.

The play will be given in two acts, the first on Wednesday, January 6th, the second on Wednesday, January 13th, each day at 3 p.m.

Special tickets are required for these performances. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to tickets admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

INDIAN SECTION.

FRIDAY, NOVEMBER 20th, 1925; LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., M.B., LL.D., F.R.S., in the Chair.

A paper on "Recent Progress in Indian Forestry" was read by PROFESSOR EDWARD PERCY STEBBING, Professor of Forestry, University of Edinburgh.

The paper and discussion will be published in the *Journal* of Dec. 11th.

CANTOR LECTURE.

MONDAY, NOVEMBER 23rd, 1925, SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E. LL.D., D.Sc., F.R.S., Chairman of the Council, in the chair. DR. R. LESSING delivered the first lecture of his course on "Coal Ash and Clean Coal."

The lectures will be published in the *Journal* during the Christmas recess.

DOMINIONS AND COLONIES SECTION.

DR. MANN LECTURE.

TUESDAY, NOVEMBER 24th, 1925, THE RIGHT HON. LORD BLEDISLOE, K.B.E., in the chair. Under the Dr. Mann Trust a lecture on "The National Parks of Canada," was delivered by MRS. JULIA W. HENSHAW, F.R.G.S., C.de G., Director of the National Parks Association, Canada.

The lecture and discussion will be published in the *Journal* of December 18th.

FOURTH ORDINARY MEETING.

WEDNESDAY, NOVEMBER 25th, 1925, MR. R. PERCY HODDER-WILLIAMS, in the chair.

The following candidates were proposed for election as Fellows of the Society :—

Finister, Harry, Huyton, Liverpool.
Hill, A. Glendon, B.A., Moor Plantation, Nigeria.
Hortor, W. E., Johannesburg, S. Africa.
Lloyd, Dr. Stewart J., Alabama, U.S.A.
Nevitt, Thomas Henry, Crewe.

The following candidates were duly elected Fellows of the Society :—

Brenner, William H., Matillas, Spain.
Goss, Edward O., Waterbury, Conn., U.S.A.
Hanna, J. C. D., Bacup, Lancs.
Johnston-Noad, Edward, London.
Kichlu, B. B. L., Multan, India.
Scharnberg, Herman J. B., Oriente, Cuba, West Indies.

A paper on "Colour Printing" was read by Mr. DAVID GREENHILL Director and General Manager, Sun Engraving Company, Ltd.

The paper and discussion will be published in the *Journal* of December 25th.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

WEDNESDAY, NOVEMBER 18TH, 1925,

MR. H. AVRAY TIPPING, F.S.A., IN THE CHAIR.

THE CHAIRMAN said that the members had met together that evening to hear a paper of the greatest interest. The history of Hampton Court seemed almost

like a fairy tale, except, he was afraid, that the story of it had not been told with the picturesqueness of Hans Andersen. If one wanted to know something about it one generally had to go to dry-as-dust documents, and especially to inventories, and they were very heavy fare. He believed the Tudor inventories of Hampton Court were very interesting in a way, but they formed rather solid reading. Mr. Goodison, however, who was a perfect ferret at such subterranean researches, was going to hand to the members that night the mature fruit of his investigations.

If one looked back upon past history it would be found that for a long time the English people had been singularly callous about preserving the interesting and splendid work of our very fine craftsmen of many generations, and many beautiful specimens had been lost, so much so indeed that it was lucky that there was something still left at Hampton Court. It was fortunate also that the Office of Works was now exceedingly keen in not only preserving everything there was, but in knowing all about it. The Office of Works could not have done better than to put that special department largely in the hands of Mr. Goodison.

The paper read was :—

THE FURNITURE OF HAMPTON COURT AND OTHER ROYAL PALACES.

By Ingleson C. Goodison.

The existing and well-known buildings of Hampton Court Palace appertain to two well-defined periods, the Tudor of Henry the Eighth, and the Stuart, or Orange Stuart of William the Third and Queen Mary.

Records are fortunately extant affording particulars of the appointments and furnishing of both epochs, but as the time at my disposal is limited, I trust my hearers will not be disappointed if I elect to deal more particularly with the work of the later period, because it will then be possible, through the kindness of Mr. Edward Hudson, of "Country Life," who has generously placed a number of remarkable photographs at my disposal, to show on the screen representations of actual pieces of furniture fortunately still surviving, instead of being obliged to trust to imperfect descriptions, which from the extreme rarity of corresponding exemplars and the impossibility of referring to originals in the Royal Palaces, must necessarily leave practically everything to the imagination.

Such a course will not, I hope, preclude brief reference to valuable sources of information regarding the productions of so brilliant and fruitful a period in design as the Renaissance, inaugurated by art-loving patrons of the calibre of Cardinal Wolsey and King Henry VIII, ever on the alert to procure articles of artistic workmanship for the embellishment of their sumptuous buildings.

Two, at least, of the principal royal palaces to which reference will be made hereafter—namely Hampton Court and Whitehall—had their origin in residences of the great Cardinal, and when acquired by Wolsey's imperious master, in the manner which is well-known to you, both must have been very completely equipped with Wolsey's magnificent collections—so rich as to constitute a nine days' wonder to all observers of the more than royal splendour of that

ostentatious prelate when in the plenitude of his power. If Wolsey, the illustrious founder of these ancient palaces, entertaining just notions of the dignity and importance of his offices in Church and State, was a magnificent patron of the arts, he was followed in possession by a King who continued, with equal address, to accumulate, within the walls of his palaces, decorative furniture and other artistic treasures, to the very last days of his life.

Among the Harley manuscripts in the British Museum the curious in such matters may find elaborate and detailed inventories of Wolsey's possessions, and a remarkable series of later inventories, taken by commission in 1547, of the appointments of Henry VIII's many palaces, and other buildings, including those of Westminster, Windsor, Greenwich, Richmond, Hampton Court, Oatlands, Nonsuch, The Tower, Woodstock, The More, Newhall, Nottingham Castle, St. John's "nigh London," and Beddington.

These inventories, in which the majority of items will be found very minutely described, afford a wealth of information regarding the furniture of Hampton Court and other royal palaces, and I am naturally loth to dismiss them without giving some indication of their contents to any of those present to whom they may be unknown. The principal items, as might be anticipated, relate to *textile* furnishings, marvellous suites of tapestry and other hangings to the number upwards of 2,000 pieces, wrought with scriptural subjects, mythological story or mediæval romance; canopies and cloths of estate, window curtains, carpets, upholstery of chairs and stools, cushions and apparel of bedsteads, in addition to which are innumerable items relating to chairs, stools, mirrors, chimney-furniture, clocks, and the musical instruments which ministered so greatly to the tastes and pleasures of the King and his family.

With, perhaps the exception of bedsteads, the woodwork of furniture constructed of that material was regarded as distinctly subordinate to the fabrics with which it was covered or upholstered. Chairs and stools are usually indicated by the material and embroidery of their coverings; the very framing to the mirrors, where of wood, was hidden usually under silks or velvets, elaborately wrought, and there are many instances of tables, cases of musical instruments and the like furniture similarly adorned, or covered with tooled and gilded leather.

Clock cases were generally of iron or copper, sometimes painted, enamelled or gilded, or of silver, while both chair frames and mirror-frames were often of metal—the former of iron, and the latter of iron or gilded copper, the mirror-plates themselves being, at this period, of burnished steel.

Reference was made in the foregoing to the exposed woodwork of bedsteads, and it is clear from these inventories that, in common with practically all woodwork of the early Tudor period—the open timber roofs, wall-panelling, fixed furniture, &c.—these were painted and gilded—" painted wallnuttre colour and pcell guilte " being the description most frequently encountered. The following descriptions are typical:—

BEDSTEADS.

Item one bedstedde the posts and heade curiouslie wrought apainted and guilte...

Item one bedstede the postes heade & foote pace curiouslie wrought & carved with the late Quenes Armes Cypher and cognisaunce painted walnuttre colour and pcell guilte...

Item one bedstede the Tester & postes of wainscotte curiouslie carved allover painted wallnuttre colour...

Item one bedstede carved painted wallnuttre colour gylte having vi balls of Alabaster pcell guilte...

Item a bedstede of wallnuttree colour, painted & pcell guilte...

Item one bedstede of wainscotte canapie facion painted redde and pcell guilte, having iiij antique clowes and iij antique boyes lykwyse painted and guilte...

I have omitted particulars of the gorgeous apparel of these bedsteads, of which one item alone must suffice :—

Item a bedsted of wood painted and gilte withe burnisshed golde... havinge ceeler Testor vi single vallaunces and thre bases of white satten all over embroderde with trailes of Tawnye clothe of golde and with Rocheforde knottes vppon the seames. The Vallaunces fringed with a deape fringe of yellawe and white silke at th'endes with a narrow fringe of the saied silke with five Curtens of redde and white damaske paned together...

CHEIRES.

Item one Cheire of yron covered all over wt nedle woke.

Item one Cheire of riche clothe of gold tissue purple having the Kinges Armes & crowne holden by his Maties beastes in the backe and fringed wt venice golde and pple Silke.

Item one chere of riche clothe of Tissue Tawney fringed wt fringe of venice gold and tawney silke.

Item ix cheires of wood covered wt cloth of gold reized wt crimson vellat fringed wythe venice gold & crimson silke one of them being a womans cheire wt H.A. crowned in it.

Item two lowe cheires of cloth of golde reized wt grene vellat fringed wt venice gold and grene silke thone having H.A. crowned embrauderde in the backe.

Item one cheir of walnuttre colour painted wt a trayle of white pcell guilte wt ye toppes guilte.

Carpets of velvet, needlework, baudekyn, silk, tapestry, " Turquey makinge " " Venice makinge," aud " englyshe making " are indicated, of course, in immense numbers. Wolsey was an indefatigable collector of carpets, as well as of tapestries, and both Cardinal and King employed numerous agents in negotiating for and engrossing the choicest products of the most famous

Continental looms and workshops. The State Papers indicate that in dealing with Henry VIII's Cardinal-Minister, a present of rich carpets or tapestries was often the indispensable overture to any embassy of importance. Sir Richard Gresham (father of the perhaps better-known Sir Thomas Gresham, founder of the Royal Exchange) was one of the agents employed by both Cardinal Wolsey and King Henry VIII in purchasing and importing suites of tapestry hangings, chairs, &c., for the equipment of Whitehall and Hampton Court palaces.

While it is impossible in the time at my disposal to give more than an indication of the contents of the royal palaces, the Inventory items relating to Clocks, Mirrors, Chimney-Furniture and Musical Instruments are of such importance as to warrant more than passing mention. The *"Clockes at Westminster in the Chardge of James Rufforthe"* included no less than thirty-nine examples of early horological art, while those at Windsor though less important numerically, were also of great interest, as the following citations may serve perhaps to indicate :—

> Item one Clocke of Iron wt a larume to the same withe the Kinges armes crowned uppon the same wt three counterbases of copper two of them wreathen and gilte and the thyrde playne and not gilte wt three small counter bases of like copper and gilte.
>
> Item one clocke of iron havinge doores of copp and not gilte wt iij belles and two men that striketh the howers uppon the toppe of the bell wt an egle gilte set uppon a case of iron colourid redd wt three great plomettes of copper and three small plomettes to the same and the same clocke havinge the change of the Mone uppon yt.
>
> Item one clocke of iron wt a larume to the same strikinge one stroke at thalfe hower wt a case of glasse sett in Iron gilte and painted with iij greate and iij small plomettes of leade.
>
> Item one clocke of copp and gilte wt a chyme to the same at thalfe hower havinge the change of the Mone wt the Kinges Armes graven uppon the dores wt three greate plomettes of copper & gilte and graven wt the Kinges and Quene Armes lres and two small plomettes like acornes gilte and the thurde wreathen all gilte.

The reference to a glass case in connection with one of the foregoing items affords an interesting comparison with one of the earliest pictorial records of a clock-case in an English house, which appears in a painting by Holbein, *circa* 1526-30, of "The Family of Sir Thomas More," now at Nostell Priory. A reproduction of this interesting picture will be found in Mr. Maurice W. Brockwell's work entitled "*The Nostell Collection*."

Almost the only relic, apart from tapestries, of Henry VIII's possessions now remaining in any of the royal palaces is a small clock at Windsor Castle, which is said to have been presented by that uxorious monarch to Anne Boleyn. This is enclosed in a case of gilded copper, about 10 inches high, pierced, chased, and engraved, and surmounted by a lion bearing an escutcheon of the

arms of England, the weights or "plomettes" being of lead encased with copper, gilded, and engraved with the initials of Henry and Anne, true lovers' knots, the royal motto, and other emblems. There is no record of the maker of this interesting relic, but clocks of this early period were probably importations or the work of foreign artisans domiciled in this country.

Mirrors, or "Glasses to loke in," figure largely among the decorative appointments of the principal royal palaces :—

> Item a square loking steale glasse sett in blew vellat all over embrowderde wt venice and damaske pearles.
>
> Item a square loking steale glasse the borders beinge silver'd with antique heades of copper and gilte laking one of the same Antique heades.
>
> Item a square lokinge stele glasse set in woode gilte & painted havinge a naked woman wt a childe in her hands on the Toppe therof the Kinges Armes subported by his graces beastes the same Armes are lackinge.
>
> Item a square lokinge stele glasse set in woode painted & gilte and on toppe therof two powmelles and a lyon holdinge a skutchion of like woode painted & gilte.
>
> Item a square lokinge steale glasse set in iron wt a cover of the same pcell gilte.

The ample fireplaces of the period were constructed to take long lengths of wood fuel, laid across great andirons, and lesser supports, called "creepers" or fire-dogs, the back of the fireplace being protected from extreme heat by firebacks of cast iron.

Supplementary heating seems to have been provided where requisite by means of transportable fire-pans :—

> Item twoo rounde pannes of iron made six square grate wise being uppon wheales to make fyre in.

Andirons appear to have been articles upon which considerable artistic workmanship was lavished and the following notices perhaps deserve citation :—

> AT THE MORE.
>
> Item v paier of Andiornes of iron having bowles of latten and labbardes heddes upon the staukes...
>
> Item two paier of Andiornes everye of them having a Roose painted white and redd uppon the sha[n]cke...
>
> Item a paier of Andiornes either Andiorne having two Kinges uppon the shanke...
>
> Item a paier of Andiornes either Andiorne having a cardinalles hatte uppon the Toppe...
>
> AT NEWHALL.
>
> Item x paier of olde Andiornes diverse of them curiousely wrought and the horsses of vi paier being broken.
>
> AT BEDYNGTON.
>
> Four gret Andiorns withe roses uppon them.

Reference has been made to the love of music displayed by Henry VIII, who was not only a performer of considerable proficiency but the composer of some creditable pieces. Henry's musical tastes were shared by Anne Boleyn and the princess Elizabeth, and consequently we find in these Inventories important records of contemporary musical keyboard and other instruments, especially the "Instrumentes at Westminster in the Charge of Philipp van Wilder," and at Hampton Court, in the custody of David Vincent, consisting of regals and virginals, single and double, chamber organs, or portatives, "upon which the skilled mechanic spent his labour and the decorator lavished his art."

> Firste a paire of double Regalles with twoo stoppes of pipes covered wt purple vellat allover embraudered wt venice golde and damaske pirles havinge the Kinge Armes and badges likewise embraudered standinge uppon a foote covered wt fustian of naples and garnished wt redd Ribon the same foote beinge the Case for the same Regalles.
>
> Item A paire of double Regalles of latten wt iij Stoppes of pipes covered wt purple vellat embrawdered allover wt damaske pirles and venice golde and the Case thereof the inner parte covered wt crimesen vellat likewise embrawdered with damaske pirles having a stele Glasse in the same and the Kinges Armes and Quene Janes Armes likewise embrawdered wt a cover the pipes covered wt crimsen vellat likewise embrawdered having a rose crowned uppon the same standing uppon a foote of waineskott painted with Rabeske woorke wherein liethe the Bellowes.
>
> Item A paire of double Regalles wt viij halfe Stoppes and one hole stoppe of pipes of woodde gilte siluered and painted wt Rabeske woorke and histories having the Kinges Armes wtin a gartire supported by his graces beastes painted and gilte uppon the trimmer of the same standing uppon a foote of woode beinge painted wherein liethe the Bellowes.
>
> Item a paire of double Regalles wt iij stoppes of pipes of woode vernisshed yellowe and painted wt anticke woorke having the Kinges Armes and Quene Janes armes wt twoo playinge uppon a lute and a harpe and twoo singinge painted uppon the same standing uppon a foote of wainskot painted yellowe with anticke woorkes...

Single regals are described as "vernisshed yellowe" and "painted with black Rabeske woorke" or "painted with blacke anticke woorke" or of "wainskott painted grene." Virginals "vernisshed grene and redd," or "painted wt grene or redd Rabeske woorke," attest the prevalence of the practice, to which attention has already been drawn, of embellishing all woodwork with painting, graining or varnishing. It is, unfortunately, the practice to-day of many who should be better informed, to strip Tudor and Jacobean woodwork, if of oak, of all traces of original colouring, painting, gilding and varnishing.

Having dealt at some length with the furniture of Henry VIII's palaces,

I am failing to reach my real objective in the appointments of late Stuart and Georgian days, which, also, have left their impress upon Hampton Court and other royal palaces. I need not detain you with particulars of any period prior to the middle of the seventeenth century when we encounter the ominous

> "Inventory of the Household Goods, Jewels, Plate, &c., belonging to the late King [Charles I]. Sold by Order of the Council of State......... From the year 1649 to the year 1652."

> "The period of Charles I" it has been observed, "is significant. It embraces the accumulation and begins the dispersal of the most notable collection of artistic treasures ever possessed by a single individual. With a splendid enthusiasm and genuine discrimination this monarch provided a rich inheritance for the English people, little dreaming that at his death it would be scattered abroad to raise funds for his enemies.........According to an inventory of the objects offered for sale, we judge that the furniture of Somerset House in Charles's day comprised many articles which have since acquired an almost priceless value. The arras hangings, tapestries, and pictures alone formed one of the most remarkable private collections ever brought together. In addition there were many magnificent carpets and cloths of state, canopies of crimson velvet and cloth of silver, clocks and mirrors of great beauty. A single bed of French satin finely embroidered was appraised at £1,000 in the currency of the day."*

The palaces and other royal residences from which Charles I's marvellous collection was withdrawn for the purposes of sale were :—The Tower, Somerset House, Whitehall, Greenwich, Wimbledon, Oatlands, Windsor, Hampton Court, Richmond, Sion House, and St. James's, and many of the items appearing in this inventory relate to superb furniture amassed by Wolsey and Henry VIII, as well as to treasures purchased with such fine judgment and discrimination by Charles I. It has been observed of that ill-fated monarch that the only art of which he was ignorant was that of reigning, and whatever his incapacity as a ruler, such records and relics of his superb collection as remain witness the soundness of his æsthetic taste, and prove that in matters artistic he was far in advance of his time. "Whatever crimes may have stained the political record of Charles the First, and led a resentful people to efface them in his blood, as a patron of the Arts the English nation remains under an obligation to him which it will be slow to understand and undesirous ever to requite."*

The establishment of the Commonwealth was accompanied by a reaction against any form of ostentation in the setting of domestic life. It is probable that little, if any, new furniture of importance was purchased for the residences of the Protector, though the fact that Cromwell when in supreme power, and accorded the outward accessories of sovereignty, retained a number of suites of hangings and certain objects of Charles's furniture, and exhibited moreover

* "Somerset House," Needham & Webster.

some solicitude for the Mortlake Tapestry works, has been advanced to prove that Cromwell was not totally averse from love of the Arts.

With the Restoration of the Monarchy, in 1660, there ensued the inevitable reaction in favour of greater luxury and comfort, and new styles in architecture, decoration, and furniture, due perhaps to the King's sojourn on the Continent and to the courtiers who had shared his exile. Many homes had been divested of their fine furniture during the Civil War, more perished in the holocaust of the Great Fire. Windsor and Holyrood were largely re-constructed, re-decorated, and re-furnished at this period, and though the work undertaken at Windsor for Charles II disappeared almost entirely in the further re-construction of 1827, much of the admirable decorative background and some particularly interesting furniture of this period is still to be seen at the Scottish palace. Charles II loved planting and building and took a keen interest in Whitehall, and among many other enterprises, projected the palace of Winchester which was in progress at the time of his death and never reached completion. The pages of Evelyn and Pepys and other observers abound with references to the splendid furniture of his day. It has been, unfortunately, more customary in the past to enlarge upon his admitted frailties than to extol his influence upon the arts, both fine and applied.

Furniture for the Royal Palaces was issued from what was known as the Great Wardrobe, which until the Great Fire of London, was situate at Puddle Wharf, Blackfriars; being removed first to the precincts of the Savoy, and subsequently to York Buildings, in the Strand. The arras-workers, or tapestry workers, were accommodated in separate quarters, in Hatton Garden, from 1679 to 1685, and subsequently in Great Queen Street "Soho," between Lincoln's Inn Fields and Drury Lane.

From the Restoration to 1671 the Master of the Great Wardrobe was Edward Montagu, 1st Earl of Sandwich, who disposed of the office in 1671 to his cousin Ralph Montagu, afterwards Duke of Montagu, for no less a sum than £14,000. Pepys records in his Diary a conversation with Lord Sandwich in which reference is made to the profits, actual and anticipated, from the office of Master of the Great Wardrobe:—

> 1662, Dec. 20.—"My Lord Sandwich acquainted me with his late enquiries into the wardrobe business to his content; and tells me how things stand. And that the first year was worth about £3,000 to him, and the next about as much, if he were paid, it will be worth about £7,000 to him."

During the brief reign of James II the appointment was held by Richard Graham, Viscount Preston, from whom it was recovered by Ralph Montagu in 1690, as the result of a successful action at law; being thence-forward held by him until his death in 1709. Ralph Montagu was succeeded by his son, John Montagu, the second Duke, who retained the Mastership until 1749. The

office of Master of the Great Wardrobe was therefore (with the exception of a brief period which has been indicated) in the hands of one family—the Montagus, from the Restoration to the middle of the eighteenth century. Of the tradesmen who supplied the appointments of our Royal Palaces to the Great Wardrobe, tapestry workers, cabinet-makers, upholsterers, lacemen, fringe-makers and embroiderers, and of the superb hangings and splendid furniture emanating from their workshops, there is ample information in official records. One is indeed embarrassed by the riches to be drawn upon, and it is matter for no little surprise that, while so much has been written upon the subject of English furniture of the seventeenth and eighteenth centuries, and so much attention focussed upon the careers of Chippendale, Ince and Mayhew, Manwaring, Hepplewhite and Sheraton, the works and names of these royal furniture makers and royal warrant holders should remain comparatively unknown. In this connection reference should be made, however, to two important articles published in "The Connoisseur" by Mr. E. Alfred Jones, in which attention was drawn to the principal royal cabinet makers from the reign of Charles II to that of Queen Anne. It is, perhaps, superfluous to mention that we owe the earliest notices of many of these craftsmen to the untiring industry and wide knowledge of Miss Margaret Jourdain.

In making an examination of official records relating to the furnishing of Royal palaces, from the Restoration to the Regency, it will be apparent that the system of sub-division into trades, and branches of trades, operated very much as it does to this day—the chair-maker, cabinet-maker, and upholsterer being then, as now, independent craftsmen. The makers of chair, stool, and couch-frames, bedsteads, canopies of estate, and window cornices, bore usually the appellation of joiners, their work including the supply, if not the execution, of both turning and carving, and varnishing, lacquering, and occasionally gilding. In this connection we encounter during the reigns of Charles II and James II the names, among others, of John Whitby, Garret Hillhurst, Thomas Kinward, Richard Price, Thomas Roberts and Alexander Fort. I shall presently have occasion to mention the names of Price, Roberts, and Fort more particularly. The chief cabinet-makers of this period were William Farnebrough and his partner John Burroughs, Gerrit Jensen, and Henry Mose—the two outstanding names being those of Farnebrough and Jensen. The principal upholsterers were John Casbert, John and Nicholas Paudevine, or Baudovin, Simon de Lobell, and Richard Bealing. Some very remarkable upholstery in the form of elaborate wrought velvet and silk bed-hangings, with chairs, stools, and window curtains *en suite* was purchased abroad by Ralph Montagu, and supplied to the Great Wardrobe at this period by "The French upholsterer" Jean Peyrard, while another Frenchman, Francis La Pierre, supplied similar upholstery to the Great Wardrobe towards the close of the reign of James II. Sumptuous materials of splendid colouring were further elaborated with embroidery by Edmund Harrison, John Best, George Pinckney,

William Redlish (or Rutlish), John Webb, Isaac Goddar, John Barbour and William West, large sums being lavished upon this very decorative branch of applied art.

Suites or sets of furniture such as the bedstead with its upholstery, wing chairs, arm-chairs, back-chairs, stools, cushions and window curtains were customary, but the set to which the most frequent reference is made consisted of a side table, a hanging mirror and a pair of stands. Few of these sets have been preserved in their integrity in the royal palaces to this day, but throughout the reigns of Charles II, James II, William & Mary, Anne and George I, they were supplied in immense numbers to Whitehall, Windsor, Holyrood, Somerset House, Hampton Court and Kensington, made in walnut, olive, ash, princes and Grenoble woods, or decorated with carving, marquetry, lacquer, and gilded gesso.

Immediately after the accession of William and Mary, considerable additions were made to the Palace of Hampton Court, and at the same time Nottingham House or Kensington House, or, as it is now called, Kensington Palace, was purchased and practically re-edified; Sir Christopher Wren, Surveyor General to the King's Works, being the architect of both projects. Queen Mary took the keenest interest and delight in the equipment and furnishing of all the royal palaces and extended the most liberal and discriminating patronage to the tradesmen of the Great Wardrobe. As one reads the absorbing pages of the exquisitely written accounts of the building, decorating, and furnishing then going forward, one is amazed at the industry, taste and knowledge which she everywhere directed. The "silent highway" of the Thames must have borne many a precious freight for the various royal palaces—for Henry VIII's Placentia and the Queen's House of Anne of Denmark and of Henrietta Maria at Greenwich, for the Tower of London, for Somerset House, Whitehall, Hampton Court, Windsor, and other royal residences and buildings; the items of "waterage," cartage, and coach hire for furniture and furniture makers are very numerous during the brief span of years within which Queen Mary was so busily and absorbingly and withal so fruitfully, employed. Wren's dignified State Rooms at Hampton Court Palace, enriched with the profitable toil of Gibbons and Verrio, were gloriously arrayed by Queen Mary and the Tradesmen of the Great Wardrobe. The superb decorative mirrors, the chandeliers of silver, gesso, and crystal, the carved and gilded torchères, the rich beds, chairs and stools with their gorgeous livery of silks and velvets of her day, are still represented, though their ranks are lamentably thinned, the sets broken, the fabrics worn and faded, the mirrors dimmed with the breath of Time—and everywhere pictures, pictures, as if all art were comprehended in painting.

Hampton Court is particularly rich in splendid decorative mirrors, those fixed to the wainscotting being supplied by Gerrit Jensen, to whom reference has previously been made. These, in their day, were decorative appointments of great price, surprising sums being lavished upon mirror-plates, elaborately

wrought, shaped, bevelled, scalloped, " brilliant cut," intagliated and engraved. Many of the borders and slips are of glass of a deep sapphire blue, attached with cut glass rosettes or facetted " jewels " of sparkling white.

Payments to Jensen for mirrors appearing among the official records relating to Hampton Court include

> " 1699-1700 for a Pannel of glass for ye first Closet with a broad Border blue Slips and Roses. 66:10:00"

in each of two rooms; corresponding mirrors in two further rooms costing £42 15s. od. each. Those for the Withdrawing Room comprising

> " 3 pannels of glass ... 13 foot 4 inches high and 3 foot 7 inches broad."

cost £171, while others for the " Painted Gardain Roome there " (now known as the Banqueting House) consisting of

> " 4 Glasses for the Peires of 62 inches long and 36 inches broad "

cost £320. Mirrors and other appointments supplied by Jensen in 1703, were apparently of corresponding importance as will appear from the subjoined extracts :—

> " ffor a large Pannell of Glass 11 foot 9 inches high and 4 foot broad £100 : 00 : 00."
>
> " ffor two guilt Tables Stands and two Glasses each 81 inches long and 45 broad with guilt Wooden frames rich and carved £450 : 00 : 00."

while the following articles for Kensington Palace furnished by Jensen in 1704-5 indicate that he found generous patronage in the early years of Queen Anne, which was far from being the case towards the close of her reign :

> " ffor two glasses in Carv'd guilded frames one glass about 68 Inches by 44 and ye other about 66 inches by 42 £190."
>
> " ffor a table stands and glass about 81 Inches by 45 Carved and guilded to match the Tables and glass in the new withdrawing room, £215."

To Newmarket, in 1705-6 Jensen supplied, among many others

> " a glass 72 Inches long and 42 Inches broad with a round top and a Carved wallnuttree frame for ye Bedchambr, £105."

The Charter granted to the Glass-Sellers' Company by Charles II in 1664, is addressed to " our loving subjects the glass sellers and looking-glass makers of the City of London."

In the previous year a warrant for a patent was issued to Thomas Tilston, merchant of London, for the sole manufacture of crystal glass and looking glass plates, and in the same year the Duke of Buckingham petitioned the King for the renewal of his patent for " making Cristall glass with a clause therein for the sole making of lookinge glasse-plates, etc." securing, not a monopoly, but the prohibition of importation of glass for mirrors, coach-plates, &c., Notwithstanding the prohibition of July 25th, 1664, we find from official accounts that John Mason in 1665 supplied " one faire Venice looking glasse " to the Great Wardrobe, and the letters of John Greene, glass seller of the Poultry,

London, to Alesio Morelli glass-maker of Venice, between the years 1667-1672, furnish particulars and sketches of extensive orders for mirror plates, some of which are to be " diamond cutt, but unfoiled," or unsilvered.

The story of mirror-glass making in Venice, France, and England, during the seventeenth century is a most fascinating and exciting one, to which I must forbear more than a passing allusion. In the words of our Chairman, "laws of almost Draconian severity" were enacted by the Venetian mirror makers to preserve the highly valuable secrets of their manufacture, and the efforts of Colbert, Louis XIV's enlightened minister and Commissioner of Works, to entice workmen from the island of Murano, to the royal workshops of France, were made in the teeth of the fiercest opposition.

Another item of equipment with which Hampton Court Palace is well endowed deserves perhaps special mention. In many rooms there are splendid chandeliers of silver, gesso, crystal, and other materials, representative of numerous corresponding accessories for artificial lighting which were freely ordered for the royal palaces, and to which many most interesting items in the official accounts relate.

In 1662 the sum of £70 was paid to George Alkington " for a faire Cristall Branch with socketts for lights," and in the same year Philip Bromfield, the gilder, supplied " ten guilt branches " and " twelve guilt socketts " to Hampton Court, while between 1666 and 1668 Adrian Bolte, or Boltee, as it is written, " Cabinet maker to His Majesty," was paid for mending " Cristall branches." There are records of many payments to Gerrit Jensen, James Catignou, Nicholas Pic and many other tradesmen for chandeliers and sconces during the reign of William & Mary and in 1716 John Gumley and James Moore supplied to St. James's Palace " a fine large Carved Wooden Branch with Brass Nozells to hold twelve Candles all Gilt with fine Gold " and for this " And for the Moddle thereof wch was prepared by his Matyes Order " claimed payment of the sum of £105. Still later, between 1733-40 Hampton Court Palace was equipped by Benjamin Goodison with " 2 silver'd metal lustres to carry 12 candles each neatly wrought and adorned with christal in being " for the very considerable sum of £560. At a far later date a cut-glass chandelier at Carlton House is described by an observer as looking " like a shower of diamonds."

In her enthusiasm for the adornment of the Royal palaces Queen Mary made many purchases and commissioned much fine furniture of fine decorative character and high artistic and intrinsic value. The wares of the " India Shops " in particular seem to have exercised a particular fascination, and an immense number of entries in the Great Wardrobe accounts are rendered under " India " " China " and " Japan " fabrics and furniture, these being convertible and synonymous terms for importations by the East India Company and other agencies.

Thus Martha Hawkins, in 1690, " craves payment " for supplying " For her Mats Service at Hampton Court."

"Tenn pieces of fine large Indian Damaske Agreed for by her Majesty at 10li per piece 100li."

while in 1694 Solomon de Medina charges £54 19s. for Indian Goods, and Guillaume Portal, merchant presents a bill of 465li 15s. for "crimson and greene flowered velvet after the Indian manner." "Sticht Indian Quilts" at £19 7s. £26 and £32 5s. were purchased from William Garway, Anne Garway, and Margaret Cooper, respectively.

A bill of Mark Anthony, merchant, in 1691 refers to the purchase, for Kensington Palace, of

"two large rich Indian Skreenes agreed for by her Majesty 250li."

Queen Mary's bed-hangings of imported Atlas and Chintz are referred to by Defoe and were considered great curiosities.

It is interesting to see that the merchants, cabinet makers and upholsterers supplying fabrics and furniture to the royal palaces found patronage in many other quarters. *The Diary* and *Expense Book* of John Hervey, First Earl of Bristol, for instance, contain many interesting entries relating to goods supplied by those bearing names which we encounter as tradesmen of the Great Wardrobe.

Whitehall is burnt, Kensington (which with Queen Mary took pride of place) is bereft of all its superb appointments, while upon Windsor and St. James's enormous sums were lavished early in the nineteenth century in obliterating "under good advice" all traces of England's great and glorious attainment in the realm of decorative Art.

DISCUSSION.

THE CHAIRMAN, in inviting discussion on the Paper, remarked that one of the things he had noticed in going through Hampton Court had been the extraordinary amount of money which seemed to have been expended on upholstery. A joiner would have turned out a very fine walnut chair at a cost of 35s., but after it had been stuffed and lined and upholstered with damasks or silks and fringes, that 35s. would have become £17 10s. od., or, taking the value of money at the present time, £170—a sum which would appear to be considerable even to our wealthy friends across the Atlantic.

MR. ERNEST LAW, C.B., said he was not an expert on furniture, but he had taken a great interest in the furniture at Hampton Court. He could remember the time when people, looking at the magnificent beds there, used to say, "This sort of rubbish ought not to be allowed here; it is all in shreds and ought to be cleared away." He also remembered the time when some of the Hampton Court furniture was sent to South Kensington; it was not appreciated at Hampton Court. He mentioned these things to draw attention to the fact that 40 or 50 years ago people did not value furniture at all. It was Mr. Percy Macquoid who had, in his great book, first drawn the attention of the English public to the immense historic and artistic interest of the furniture contained in the Royal Palaces, museums and private houses. In his opinion English craftsmanship in the matter of furniture, not merely as articles of ornament, but as articles of use, took precedence over even the very finest of French craftsmanship.

He thought attention should be drawn to the fact that during the last year or two the furniture in Hampton Court Palace had been arranged in a much better way than it had formerly been. Formerly it had been arranged in a most unsuitable fashion. For instance, George the Second's bed was put into William the Third's room. Now, however, by the efforts of the Office of Works the furniture had been re-arranged, and William the Third's bed had been put back into his room, and it harmonised in a most beautiful manner with everything else in the room; the whole place looked quite different. The same applied to the Queen's Bed Chamber. In Hampton Court the public had a historical building, showing in a way in which no museum or book could show, a historic demonstration of the history of English furniture.

The Chairman said he would like to take the present opportunity of saying that Mr. Ernest Law reminded him of the time when his was a voice, as it were, crying in the wilderness. It was only by Mr. Law's work in arousing the Office of Works that Hampton Court was in the admirable condition in which Mr. Law delighted to find it. In saying that he did not forget that much of the improvement was due to Mr. Goodison as an Officer of the Office of Works.

Captain E. W. Gregory said he would like to know whether Mr. Goodison suggested that the public in furnishing its homes to-day should go to the past. Supposing, for instance, somebody went to Messrs. Maple and said, "I want a beautiful and fashionable home," would Mr. Goodison suggest that the firm should supply Queen Anne furniture, Chippendale furniture and furniture of the 17th and 18th centuries? Had we no furniture of our own to-day? Did we make nothing to-day? Was there no fashion in furniture to-day? It seemed to him that we should at least be able to produce something which was of our own fashion.

Miss Euphemia Smith remarked that in going through Hampton Court and other places, she had been struck with the style of furniture therein. It was beautifully carved, painted and upholstered, but it did not appear to convey the slightest sense of comfort. All the chairs, for instance, were hard to sit upon. The furniture of to-day, on the other hand, was all manufactured with a view to comfort. There was comfort in every chair, a thing which was not seen in any specimens of old furniture. She had visited Hatfield some time ago and she had observed that there was not a chair there in which one could lean back; all the backs of the chairs were upright. Present day chairs and couches were exceedingly restful. Comfort was certainly absent in the furniture of old days, and she much preferred a modern chair to rest in.

The Chairman said comfort was a wonderful thing, but there were some who thought that art was something almost greater than comfort, although he quite agreed that it would be a very good thing to combine the two.

Mr. Goodison, in reply, said he would like to clear up a little misapprehension. He had been referred to as having had something to do with the furniture arrangements at Hampton Court. That was not within his province at all, and, therefore, he could take no credit for it. Mr. Law was the watchdog at Hampton Court Palace; he was responsible for most of the improvements which had taken place there, but personally he was far from agreeing with Mr. Law that the present arrangement was ideal. He thought the present arrangement of the furniture

and pictures left very much to be desired, and personally he infinitely preferred the old arrangement to the new. With regard to the question raised by Captain Gregory, he did not think that could be fairly brought under the subject of his paper, and, as time was getting on, he would only reply that he would see Captain Gregory outside!

MEETINGS OF THE SOCIETY UP TO CHRISTMAS.

ORDINARY MEETINGS.

DECEMBER 9.—At 4.30 p.m.—(Joint Meeting of the Indian and Dominions and Colonies Sections.)—A paper on "The Imperial College of Tropical Agriculture," by H. MARTIN LEAKE, M.A., Sc.D., F.L.S., Director of the College, will, in the absence of the Author, be read by ARTHUR WILLIAM HILL, Sc.D., F.R.S., Director, Royal Botanic Gardens, Kew. The HON. W. ORMSBY-GORE, M.P., Under-Secretary of State for the Colonies, will preside.

CANTOR LECTURES.

Monday evening, at 8 o'clock.

R. LESSING, Ph.D., F.C.S., M.I.Chem.E., "Coal Ash and Clean Coal." Three Lectures. November 23, 30, and December 7.

LECTURE III.—Influence of mineral constituents on the utilisation of Coal. Chemical and physical behaviour in combustion process. Pan Ash cleaning. Melting point of ash. Behaviour in Gas Producers. Influence of inorganic constituents on the carbonising process. Catalysis in coking gas making and low-temperature carbonisation. Quality of Coke. Influence on hydrogenation and total conversion of Coal into oils. The clean Coal of the future.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 7..Farmers' Club, at Royal United Service Institution, Whitehall, S.W. 6 p.m. Mr. J. Hammond, "Fertility and Sterility in Domestic Animals."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Mr. C. L. Lipman, "Design and Performance of Protective Relays."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Professor L. W. Collet, "The Lakes of Scotland and of Switzerland."

Selborne Society, at the Civil Service Commission, Burlington Gardens, W. 1. 6.30 p.m. Mr. Paul Edmonds, "Sketches of Burma." Mr. W. O'Donoghue, "The Tower of London." Mr. Joseph Clark, "Saint Joan." The Rev. E. J. Clifton, "Persian Cats and Carpets." Mr. A. B. Searle, "The Potter's Wheel."

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Col. C. H. Bressey, "Modern Methods of Roadmaking."

Structural Engineers, Institution of, at Birmingham. 7.30 p.m.

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, Embankment, W.C. 5.30 p.m. Mr. A. Hacking, "Some Financial and Political Aspects of Highway Development."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Mr. G. B. Michell, "Scientific Criticism of the Bible."

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

University of London, at Kings' College, Strand, W.C. 6 p.m. Mr. H. Wickham Steed, "Central Europe and the War." (Lecture III.) 5.30 p.m. Dr. W. T. Gordon, "Geology and Civilisation." (Swiney Lecture IX.)

At the School of Oriental Studies, Finsbury Circus, E.C. 5.30 p.m. M. Joseph Hackin, "Les Monuments Bouddhiques et les Antiquités Musulmanes de l'Afghanistan." (Lecture I.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. Otakar Vocadlo, "From Bohemia to Czechoslovakia." (Lecture V.)

Institute of Chemistry and Society of Chemical Industry. (Joint Meeting.) At Institution of Mechanical Engineers, Storey's Gate, S.W. 8 p.m. Mr. W. J. U. Woolcock, "Five Years of Progress in the Fine Chemical Industry."

Engineers, Society of, at Burlington House, Piccadilly, W. 5.30 p.m. Mr. H. E. Irving Taylor, "The Growth of the Gothic Church Window."

TUESDAY, DECEMBER 8.. Anthropological Institute, 52, Upper Bedford Place, W.C. 1. 8.15 p.m. Capt. A. M. Hocart, "The Buddha's Illumination."

Colonial Institute, at Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m.

Electrical Engineers, Institution of, at Hotel Metropole, Leeds. 7 p.m. Prof. S. P. Smith, "An All-Electric House."

At Royal Technical College, Glasgow. 7 p.m. Major E. I. David, "Electricity in Mines."

At the College, Loughborough. 6.45 p.m. Mr. F. J. Moffett. Chairman's Address.

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. M. L'Herminier, "Powdered Fuel Developments."

Physiology, London College of, 8, Taviton Street, W.C. 1. 8.15 p.m. Mr. Norman Morrison, "The Life Story of the Common Eel."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. F. J. Tritton, "On the Theory of the Carbon Process." Messrs. E. L. Turner and D. C. Hallam "The basis of the Image in Photo-Lithography." Messrs. T. Thorne Baker and L. F. Davidson, "A New Physical Method for the Examination of Gelatine."

Automobile Engineers, Institution of, at Broadgate Café, Coventry. 7.30 p.m. Mr. W. Ferrier Brown, "Sleeve-Valve Engine Development."

University of London, at the School of Oriental Studies, Finsbury Circus, E.C. 5.30 p.m. M. Joseph Hackin, "Les Monuments Bouddhiques et les Antiquités Musulmanes de l'Afghanistan." (Lecture II.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "History of Russia before Peter the Great." (Lecture IX.)

Mechanical Engineers, Institution of, at University College, Swansea. 6 p.m. Mr. G. E. Hider, "Some Factors affecting the Economy of Reciprocating Engines with special criticism on Uniflow Engines."

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.30 p.m. Messrs. J. H. S. Dickenson, P. B. Gray, and F. E. Cherry, "The Selection and Properties of Steels used for Oil Well Boring Equipment."

WEDNESDAY, DECEMBER 9.. Chadwick Lectures, at Royal Society of Medicine, 1 Wimpole Street, W. 5.15 p.m. Dr A. Salusbury MacNalty, "Encephalitis Lethargica (Sleepy Sickness) in England."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. C. H. J. Clayton, "The Use of Explosives for Scouring Purposes in Tidal Rivers."

Royal United Service Institution, Whitehall, S.W. 3 p.m. Commdr. J. G. P. Vivian "The Empire Cruise."

Public Health, Royal Institute of, 37, Russell Square, W.C. 5 p.m. Prof. J. C. G. Ledingham, "Current Problems in Bacteriology and Immunology and their Bearing on Public Health Effort." (Harben Lecture I.)

University of London, at University College, Gower Street, W.C. 5.30 p.m. Dr. C. F. Sonntag, "Man's Place in Nature." (Lecture III.)

Mechanical Engineers, Institution of, at Brown-Firth Research Laboratories, Sheffield. 7.30 p.m. Mr. H. F. L. Orcutt, "Characteristics and Uses of Ground Gears."

THURSDAY, DECEMBER 10.. Antiquaries, Society of, Burlington House, Piccadilly, W. 8.30 p.m.

Child-Study Society, 90, Buckingham Palace Road, S.W. 6 p.m. Dr. R. Langdon-Down, "The Teaching of Shorthand as part of a General Education."

Electrical Engineers, Institution of, at Trinity College, Dublin. 7.15 p.m. Mr. J. Lindsay, "The Mechanica Winning of Peat."

At University College, Dundee. 7.30 p.m. Mr J. K. Murray, "Some Features of Telegraph Engineering."

Historical Society, 22, Russell Square, W.C. 5 p.m. Miss M. V. Clarke, "The Irish Parliament in the Reign of Edward II."

London County Council, at the Geffrye Museum, Kingsland Road, E.2. 7.30 p.m. Mr. A. Carr, "Timber Trees, Growth, Structure and Defects."

Metals, Institute of, at 85-88, The Minories, E. 7.30 p.m. Mr. J. B. Hoblyn, "Commercial Aluminium Alloys from the Users' Point of View." (Joint Meeting with the Institution of British Foundrymen.)

Optical Society, at Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.

Oil and Colour Chemists' Association, at Painters' Hall, Little Trinity Lane, E.C. 4. Joint discussion with the Incorporated Institute of British Decorators on "The Conditions of Application which influence the Durability of Paint and Varnish."

Structural Engineers, Institution of, at Great Northern Hotel, Leeds. 6.30 p.m. Mr. E. F. Sergeant "Concrete Granary at Hull."

Public Health, Royal Institute of, 37, Russell Square, W.C. 5 p.m. Prof. J. C. G. Ledingham, "Current Problems in Bacteriology and Immunology and their Bearing on Public Health Effort." (Harben Lecture II.)

Constructive Birth Control, Society for, at Essex Hall, Essex Street, Strand, W.C. 8 p.m. Mme. André Rieder, "Population Problems in the Near East."

University of London, at King's College, Strand, W.C. 5.15 p.m. Mr. A. D. Lindsay, "Benedict Spinoza" 5 p.m. Dr. C. Da Fano, "Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System." (Lecture X.)

At the School of Oriental Studies, Finsbury Circus, E.C. 5.30 p.m. M. Joseph Hackin, "Les Monuments Bouddhiques et les Antiquités Musulmanes de l'Afghanistan." (Lecture III.)

FRIDAY, DECEMBER 11.. Astronomical Society, Burlington House, Piccadilly, W. 5 p.m.

Junior Institution of Engineers, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. J. S. Highfield, Presidential Address.

Metals, Institute of, at the University, Sheffield. 7.30 p.m. Prof. F. C. Thompson, "Nickel Silver."

At University College, Swansea. 7.15 p.m. Prof. J. H. Andrew, "Modern Metallurgy."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. 1 Dr. E. A. Owen and G. D. Preston, "On the Effect of Rolling on the Crystal Structure of Aluminium." 2. R. S. Burdon, "The spreading of one Liquid on the Surface of another." 3. J. T. Combridge "On the advance of the Perihelion of Mercury."

Public Health, Royal Institute of, 37, Russell Square, W.C. 4 p.m. Dr. Percy Hall, "The Role of Light in the Prevention and Arrest of Disease."

5 p.m. Prof. J. C. G. Ledingham, "Current Problems in Bacteriology and Immunology and their Bearing on Public Health Effort." (Harben Lecture III.)

University of London, at King's College, Strand, W.C 5.30 p.m. Dr. A. W. Reed, "The First Tudor Theatre."

5.30 p.m. Dr. W. T. Gordon, "Geology and Civilisation." (Swiney Lecture X.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "Serbia and the Jugo Slavs." (Lecture IX.)

Mechanical Engineers, Institution of, at Philosophical Hall, Leeds. 7.30 p.m. Prof. G. F. Charnock, Chairman's Address.

SATURDAY, DECEMBER 12.. London County Council, at the Horniman Museum, Forest Hill, S.E. 3.30 p.m. Dr. H. Graham Cannon, "Floating Life in the Sea."

Transport, Institute of, at the Town Hall, Newcastle-on-Tyne. 3 p.m. Mr. R. C. Mayes, "The Organisation and Working of the Royal Victoria and Albert and King George V. Docks of the Port of London Authority."

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FRIDAY, DECEMBER 11th, 1925.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

JOURNAL OF THE ROYAL SOCIETY OF ARTS

NOTICES.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, Professor Henry E. Armstrong, F.R.S., will present to a juvenile audience *Alice, in Wonderland, at the Breakfast Table.* He will be aided and abetted by Alice, Mac Hatter, The Dormouse, the March Hare, Brer Rabbit, the Cook, the Duchess, Father Christmas and Tar Baby.

The play will be given in two acts, the first on Wednesday, January 6th, the second on Wednesday, January 13th, each day at 3 p.m.

Special tickets are required for these presentations. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to tickets admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

CANTOR LECTURE.

MONDAY, NOVEMBER 30TH, 1925. DR. R. LESSING, Ph.D., F.C.S., M.I.Chem.E., delivered the second of his course of three lectures on "Coal Ash and Clean Coal."

The lectures will be published in the *Journal* during the Christmas recess.

FIFTH ORDINARY MEETING.

WEDNESDAY, DECEMBER 2ND, 1925. COLONEL SIR THOMAS A. POLSON, K.B.E., C.M.G., in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

Frank Merricks, A.R.S.M., M.Inst.M.M., London.
Samuel Franklin Skellorn, M.Inst.Mar.E., Cape Town, South Africa.
Sir Gilbert T. Walker, C.S.I., Sc.D., F.R.S., Cambridge.

The following candidates were duly elected Fellows of the Society:—
The Hon. Mrs. Fitzalan-Howard, London.
William Moorcroft, Trentham, Staffs.

A paper on "The Future of the Motor Car," was read by LIEUT.-COLONEL SIR ALAN H. BURGOYNE, M.P., Companion Inst.Mech.E., M.Inst.P.T., A.Inst.A.E.

The paper and discussion will be published in the *Journal* of January 1st, 1926.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, NOVEMBER 20TH, 1925.

LIEUT-COL. SIR DAVID PRAIN, I.M.S., C.M.G., C.I.E., LL.D., F.R.S., in the Chair.

THE CHAIRMAN said that some who were present that evening might have had the opportunity of reading the striking impressionist sketch by Professor Stebbing, which appeared in the Jubilee number of "The Indian Forester" of the present year, and those who had read it would look forward with pleasure to the filling up of the picture of which that was an outline; and those who had not read the article would have that evening the advantage of hearing an account of Mr. Stebbing's visit to India.

The paper read was:—

RECENT PROGRESS IN INDIAN FORESTRY.

By PROFESSOR E. P. STEBBING, M.A., F.L.S.

In March, 1910, a paper on "Indian State Forestry," by Sir Sainthill Eardley Wilmot, K.C.I.E., was read before this Society. Other papers* dealing with the subject have been presented both before and since, and are recorded in the Society's Journal. Nearly 16 years have elapsed since Eardley Wilmot's paper was written—years which have witnessed great progress in Indian Forestry.

Eardley Wilmot referred to the inauguration of the Forest Research Institute at Dehra Dun. He was the founder of the Institute in 1906, having obtained the support of that clear-visioned and most able Administrator and Viceroy, the late Lord Curzon. To the foundation of the Research Institute and to the work done by some able Research Officers, entirely drawn from the Forest Department at the outset, may be attributed much of the professional and technical advance made by the Department in the last decade. And curiously enough, the Great War, by leaving India to a great extent dependent on her

* Col. A. R. Wragge, 'Indian Forests and Railways' (1871); Sir Richard Temple, Bart., 'Forest Conservancy in India' (1881); Sir W. Schlich, 'The Utility of Forests and the Study of Forestry' (1890); Mr. R. S. Pearson, C.I.E., 'The Recent Industrial and Economic Development of Indian Forest Products' (1917); Prof. R. S. Troup, C.I.E., 'Indian Timbers' (1921); Mr. A. L. Howard, 'The Timbers of India and Burma' from a commercial point of view (1922).

own resources, materially assisted in the progress. But it would be invidious and unfair to credit the advance solely to these causes. There were able men in the Department before the advent of the Research Institute, men who observed and experimented, though unfortunately the records of many of their investigations were never committed to paper. But the accumulating effect of this work was there and the clever brains of a later generation seized upon and classified the information which existed and, as I hope to show, the results in a few short years have placed the Department, in some respects and in some localities, in a position professionally second to no other in the world.

I have been engaged upon a history of the Indian Forests for the past six years and to this fortunate though arduous undertaking I owe it that, with the aid of and at the invitation of the Government of India, I was able to re-visit India this year, go round the provinces and see for myself something of this wonderful progress. I re-visited many places I was previously acquainted with, and I propose to endeavour to place before you something of what I saw. I realise the difficulties of this task. The country we know is large and the forests widely distributed. I saw instances of remarkable, at times almost unbelievable, progress in every Province, and my space in one short paper is restricted.

In view of the record of the past in the *Journal* of the Society my remarks will be confined to recent progress. For those interested in historical development it may be suggested that this progress dates from the advent of the Research Institute, and holding that belief I propose to glance briefly at its activities in the first instance.

The Institute sanctioned, Eardley Wilmot selected the officers to fill the posts from the Department, the posts being Sylviculturist, Superintendent of Working Plans (subsequently abolished), Forest Botanist, Forest Zoologist, Economist and Forest Chemist. Later, pulp and tan experts were appointed on short contracts. The old Forest School was given the status of a College and the research officers were required to give courses to the classes in their special branches. The difficulties encountered at the start were the unavoidable ones of an almost total absence of accommodation and small staffs. Forest Botany was well housed, but the rest had to make do with very inadequate quarters. The chief work undertaken in all branches during the first few years, in addition to touring and a certain amount of investigation, was connected with the collection of statistics and data scattered about the country in reports, memoranda and so forth, and opening out ledger files. Experimental work was carried out in Sylviculture, botanical investigations were undertaken as also insect investigation work, and the Economist and Forest Chemist, working under extreme limitations, commenced investigations and experiments which in the case of the former were to lead to an extraordinary development. During these years Mr. L. Mercer, C.I.E. was President

and building was carried on, but it was not till 1913 that the Forest Institute building was opened, it being considered at the time that ample provision in accommodation had thus been made for at least 20 years. The Institute grounds covered an area of 47 acres; the cost of the land amounted to R.1,68,000. In addition to the main building, ample and fully-equipped laboratories and workshops for the Economist and Chemist and an Insectary were erected in the grounds, as well as students' quarters to house the recruits under training for the Provincial Forest Service. The total outlay amounted to R.5,08,000. The main block in addition to providing offices, class-rooms, etc., contained the Museums of the Sylviculturist, Economist, and Forest Zoologist. The building and its arrangement were probably the finest to be found in the East. A year after the opening the Great War burst on the World. The forces upon the Eastern Fronts in Mesopotamia, Egypt, Salonika, Aden, East Africa and Persian Gulf Ports had very soon to depend mainly upon India for their requirements, and the Forest Department was faced with heavy and urgent demands for timber, fodder, and other produce. Calls were made upon the Institute, especially on the Economist branch. Many timbers were being utilised which had been unmarketable before and a great impetus was given to experimental research in many directions. The heavy initial work of the first few years in the collection of existing material and statistics now bore fruit. The Government of India had become fully alive to the remarkable development which was taking place and to their indebtedness to the Institute for the work carried out during the War. It had already outgrown in all branches the building opened in 1913, but more especially so in the Economic Branch. The great and increasing value of this branch made a readier appeal, the financial one, to the non-forestry expert, but it had fully earned the high praise accorded it. In 1918 the position was reviewed, and schemes were developed for enlarging the Institute and approved early in 1919 at the Triennial Conference of Conservators from all Provinces. The staff was to be considerably increased. The ground available in the existing Institute was not sufficient for expansion on any large scale, nor could an adequate area to allow for future extension be secured in the vicinity. A far larger scheme received the sanction of Government. A new Research Institute building was to be erected. For this purpose and to allow for all probable future expansion an area of about 1,300 acres a few miles outside Dehra was acquired at a cost of R.12,82,000. The new Institute building with the necessary workshops, laboratories, officers' quarters, and those of the subordinate establishment, was estimated to cost a sum of R.1½ crores. The most urgent part of the programme was the erection of the Economic workshops and laboratories with quarters for the connected staff, since the work of this branch was being hampered for the want of up-to-date plant. This part of the new Institute has been erected at a cost of R.22,33,000 and R.5,22,000 have been expended on the equipment. One wing of the new main building is under

construction. It will be seen that the new Institute is cast in a giant mould. The Inchcape Retrenchment Committee, who found themselves unable to sympathise with the expansion, considering that some of the research work could be left to private enterprise, although nothing in the previous history of the Department lent colour to this idea, advised considerable cuts in the sanctioned expenditure. The building programme was put on a 3 year block grant, which fortunately did not interfere with the more important work, and it is understood that more far-seeing councils have prevailed and there is every hope that the original programme will be carried out. India will then be in possession of not only the finest Forest Research Institute in the East, but it will be unrivalled in the world.

A few words upon the work of the branches. They must be regrettably brief. Triennial programmes of the work to be carried out are now prepared.

The officer who really started the work of the *Sylvicultural Branch* in 1909 was Professor Troup, now Professor of Forestry at Oxford. His predecessors had been Messrs. Hobart Hampden, J. H. Lace, C.I.E., and A. M. Caccia, C.B. Caccia was the first Superintendent of Working Plans and carried out some good work. The combination of the two posts for a short time was not a success. Troup set to work and with painstaking patience collected the mass of information in existence, but unutilizable in its then form, and sorted and filed it for future use. He carried out tours throughout the country, instituted series of sample plots for ascertaining the rate of growth, &c., of different species, undertook research into the germination of some valuable species and, even more important, advised local forest officers in matters dealing with the sylvicultural management of the crops with the object of introducing more advanced methods and the replacing of the old selection system by systems admitting of more intensive management. Troup was instrumental in introducing in some localities the concentrated method of regeneration by *toungya*, the Burmese term for shifting cultivation, which will be alluded to later in this paper. He compiled, as a result of his work, his valuable *Sylviculture of Indian Trees*. Mr. Marsden followed Troup and concentrated his attention on collecting statistical data on rates of growth from divisional records. An outcome of the work may have been said to be the first Sylvicultural Conference which met at Dehra in 1918, at which methods of collecting future data were standardized. The present Sylviculturist, Mr. Howard, has been engaged, together with local sylvicultural officers appointed in the provinces, notably Messrs. Trevor, Conservator of Working Plans, and Smythies in North India, in preparing statistical tables of yield from species such as *sal*, deodar, and *Pinus longifolia,* whilst Maitland in the Central Provinces has prepared a *sal* and teak volume table, and Blanford, Conservator of Working Plans in Burma rough tables for teak, pyinkado, *Dipterocarpus tuberculatus* and *Terminalia tomentosa* for certain localities. The value of the work which has resulted in the application of sylviculture to the Working Plan is incalculable

and its effects can be seen in certain localities throughout India at the present day; and we have object lessons in the practice of forestry, few as yet, but present, comparable to the best to be seen in Continental Europe. The fine photographic branch of the Institute is under the Sylviculturist.

The work of the *Forest Botanist* was under Mr. Hole from the start to 1924. The work accomplished falls under 4 heads: (1) Education. Hole published a Botany Manual which was favourably commented upon by Sir David Prain. (2) Systematic Botany. The object was to disseminate as widely as possible amongst forest officers a good knowledge of the names and economic uses of forest species, firstly, by encouraging the publication of floras and descriptive lists, and secondly, by identifying specimens from enquirers. A flora has recently been published for the Punjab and descriptive lists for the Central Provinces. It was recognised that a good botanical library and a good herbarium were necessary. Since 1908 more than 20,000 sheets have been added to the herbarium in addition to Mr. Duthie's valuable Saharanpur herbarium incorporated in 1908. (3) Diseases of Trees. Considerable work on soil aeration in relation to root diseases was carried out. (4) Oecology. Under this head work was undertaken by Hole on soil aeration as a factor influencing the growth of plants, especially *sal*. A large series of experiments were carried out with *sal* especially in connection with the factors influencing the growth of seedlings. Mr. R. N. Parker, who is now in charge, has been chiefly occupied with the herbarium. In 1925 there were nearly 40,000 sheets in the herbarium of which 18,000 have been collected in the last four years. Mr. Parker rightly deplores that no Mycologist has yet been appointed to the branch and that its staff has never been equal to the work to be carried out.

The post of *Zoologist* or *Entomologist* is the oldest of the research posts, since it was first inaugurated in 1900. After several years of pioneer work, Dr. Imms was appointed to the post and progress developed on three main lines—a reference collection of insects, a reference library and adequate laboratory and insectary equipment. Imms also carried out research on lac (*Tachardia lacca*) and the *Pinus longifolia* scale (*Ripersia resinophila*). Dr. Beeson was appointed when Imms resigned, and he had the good fortune to commence work in the new Research building with well-equipped laboratory and insectary. His work has been primarily directed towards an extensive survey of forest insects from an oecological standpoint. He has carried out successful work in combating attacks of pests such as the *sal* heart-wood borer (*Hoplocerambyx spincornis*), the beehole borer of teak (*Xyeutes ceramicus*) and so forth. The post of Systematic Entomologist in the branch has been filled by Dr. M. Cameron and Mr. J. C. M. Gardner.

In the *Chemistry Branch* work of considerable value has been carried out, especially after 1914, when sufficient laboratory equipment became available. The demand for analytical work steadily increased at the expense of the possibility of undertaking original work. A certain amount of investigation work

was put through with the object of demonstrating the possibilities or otherwise of developing certain industries on a commercial scale. The branch is of necessity closely associated with the Economic Branch. Investigations carried out have been into Tanning extracts, distillation of turpentine from the resins of Indian pines, the possibilities of Pine needle oil, the chemical properties of the natural varnish, *Malanorrhœa usitata*, which have been proved identical with Japanese lacquer varnish; the first researches into the manufacture of Thymol from "Ajowain" seeds were made at the Institute, and have resulted in the erection of a factory in the Dun which supplies a large part of the World's requirements. Puran Singh was the first Forest Chemist. Under the re-organisation Dr. Simonson was appointed in 1919 and held the post till 1925.

Lastly we come to the *Economic Branch*. Almost from the start (Troup held the post for 2 years) this branch has been under Mr. R. S. Pearson, C.I.E., a son of Colonel Pearson, one of the pioneers of the Forest Department. The growth of the Economic branch is due to Pearson, backed up by the Presidents, Messrs. Mercer and B. B. Osmaston, followed by Mr. W. F. Perrée, C.I.E., the able President who carried through the great schemes for the new Institute. Both Perrée and Pearson saw the erection of the new Economic buildings on the new site and saw them all functioning before both left India this year.

In the space of this article it is a difficult feat to portray the growth of the branch. From a small shed in the compound of the old Forest School where Pearson carried out his first experiments in wood preservation there are now in existence perhaps the finest Research buildings and plant in the world. The growth to the present dimensions has been due to a correct analysis of the lines upon which research should proceed. There are 3 stages. The first is the purely scientific enquiry, usually ending in the laboratory stage. The second involves an inventory in the forest to ensure the maintenance of the supply of raw material, together with the manufacture on a scale sufficient to test the market value and suitability of the materials or products in question. If this fails to establish a demand, the third stage, comprising the erection of pioneer plants or factories, will be necessary. The research now being carried out aims at the first and in certain directions, *e.g.*, paper pulp, the second stage. As in the case of the other branches classification of records already in existence was commenced in Record files. In 1909 the post of Reporter on Economic Products to the Government of India was abolished, and the records dealing with Forest products, collected by Sir George Watt and his successors, were transferred to the Economist's office. He had also the "Dictionary of Economic Products," Gamble's "Manual of Indian Timbers" and other reference works to refer to; also a nucleus collection of timbers and minor products at the Forest College. The first years were passed in the initial work and in the wood preservation experiments. An enquiry into possible matchwoods had already been undertaken by Troup. The utilisation of bamboos for paper pulp followed and Mr. W. Raitt, an expert, was obtained from home. The

scope of the sleeper enquiry was developed and many other enquiries followed. It became recognised that the branch would have to be split up into several sections. In the 1913 building two large Museums were allotted to the branch, the workshops consisting of a Timber Testing Workshop, an experimental timber treating plant (open tank method) and storage rooms. Later a small wood workshop and a seasoning kiln were added. The difficulties at this time were to get the right type of machinery and the necessary experts. These difficulties were surmounted and the buildings, etc., now in full working order at the new site, consist of the following :—The latest type in log ponds leads into the sawmill where the logs are broken down and cut roughly into the dimensions required for the experimental work in the various branches. Next come the seasoning kilns where the experimental seasoning of various types and grades of material is undertaken in either a Sturtevant or Tieman kiln. This section is under Mr. Fitzgerald. Mr. Raitt is in charge of the paper pulp section. A plant has been set up which is capable of demonstrating the whole process of paper making, and Mr. Raitt, as a result of much patient work, has at length discovered the secret of producing a good paper from bamboos. Experiments with various grasses have also been undertaken in which Hole collaborated. The wood preservation plant is under Mr. J. H. Warr. Here important investigations in connection with impregnating sleepers of various timber species are being carried out. As a result of the work accomplished in this section the N.W. Railway have erected a large sleeper treatment plant at Dhilwan on the Beas River for *Pinus longifolia*, and other species. The durability tests on the pine sleepers have proved to the Railways the possibilities of this timber. Other plains forest timbers are being similarly treated and tested in the section. The section of Timber Testing is under Major L. N. Seaman, B.Sc., M.E.I.C., from the McGill University. This is indisputably the finest timber testing laboratory in the East and is fitted with a variety of machines from compression to impact. Eighteen foot beams for constructional purposes can be tested in this laboratory. Lastly, the wood workshop is under Mr. W. Nagle, an expert in his own line. Here the specimens are prepared for the various sections, over 100 a day being turned out for the timber testing section alone. The section is engaged in preparing panels of 5-ply and 7-ply wood of different Indian species for panelling the legislative Assembly Hall at New Delhi; I saw some magnificent panels already finished. In Minor Products some good work was undertaken for a time by Mr. W. A. Robertson. Owing to lack of funds the post is vacant. The Research work to be undertaken in this branch should be of incalculable value.

The following will most fittingly illustrate the work of this branch without further comment on my part. I travelled home with Sir Clement Hindley, Chief Commissioner of Railways in India. The Railways in the past have not always seen eye to eye with the Forest Department over sleeper matters. I had several talks with Sir Clement and before he returned to India he kindly

wrote me a Memorandum (dated Sept., 1925,) on the Research Institute. I give the following extracts:—" The Forest Research Institute at Dehra Dun has already rendered services of supreme importance to the Railways of India, but there is still a vast field of work to be covered, and there is in fact in the nature of the work no possibility of its ever being finished or completed. We are perhaps only at the beginning of the methodical and systematic work which is continuously necessary if the Railways are to secure the best available material at prices which can be regarded as commercially profitable. This is one of the problems which a commercial concern like a Railway has ever before it, but it is a problem which has become accentuated by the rise of costs in all directions and the consequent need for economy. It is also a problem which, like others relating to economical working, has become more prominent by reason of the recent separation of railway finances from the general finances of the country, whereby the onus of producing an adequate return on invested capital has been laid on the Railway Board. The Railways require an organisation which will conduct investigations on scientific principles into the physical characteristics of available timbers and into the sources of supply. These investigations must be done by standardized methods and essentially co-related with the class of work required from the material. The results of such investigations must be put at the disposal of every engineer and every purchasing officer and in a form which is capable of appreciation by those who are to some extent in ignorance of the scientific side of the subject. Ignorance of the sources of supply of available and suitable timbers, ignorance of the physical characteristics of available species, and perhaps ignorance of the need for research, has been the direct cause of unnecessary recurring costs and the extension of the use of artificial and expensive substitutes. With an abundant supply of timbers of innumerable species all round us we have hitherto confined ourselves practically to the use of teak, deodar, and *sal*, with the result that scarcity and high prices have confronted us on many occasions.

With the Research Institute working for us and giving us scientific results of real commercial value we can look forward to an extension of the use of timbers and an enlargement of the species made available for railway work." . . . . . .

" It is hardly too much to say that the potential value of the Institute to the railways is so great that if it were not in existence those responsible for the administration of the railways on commercial lines would have to create some such organisation to 'take care of' the scientific side of timber treatment and use."

It should be pointed out that the coming of the Research Institute and the work it has been engaged upon would not in itself have enabled the Department to profit, had not a more generous financial policy been exercised during the present century. Re-organizations of the staff have taken place, and money has been made available for road construction and other ex-

traction works. With the increase in work owing to more intensive management of the forest areas forest circles have been split up and, to a greater degree, forest divisions have been divided and sub-divided. Instead of the 18 Conservator of Forests posts which existed in 1901, there are to-day 36; of the 36 Conservators five are Conservators of Working Plans or Utilization. In addition there are six Chief Conservators, the only provinces without one being Bengal, Assam, and Bihar and Orissa. These officers act as Advisers to the Local Governments. The staffs of Deputy and Assistant Conservators as also Provincial Service Officers have been greatly augmented. The subordinate staff has also of necessity largely increased—though one often heard out in India that the Ranger class, the backbone of the Divisional Officer's staff, was sadly deficient in some parts. Most provinces have also Sylvicultural Research Officers who work in conjunction with the Research Institute Sylviculturist.

A few remarks must be made about fire-protection of the forests. In no other branch of forest administration in India have opinions so changed as on this momentous question. It almost amounts to a revolution. Before the close of last century a brilliant forest officer in Burma, H. Slade, first questioned the correctness of the practice of indiscriminate fire protection for all classes of teak forest. From the Inspector-General downwards the idea was treated with scorn. It may be stated at once that incalculable direct and indirect benefits have resulted from fire-protecting the forests. Owing to the steady support given by the Government in this matter it is probable that the people became the sooner educated to respect the Reserved Forests, and large areas of forest have enormously benefited by half a century of protection. Slade's query was taken up by a few forest officers and it had relation not to the forests as a whole, but to a certain type of moist teak forest. The first result in Burma was a stiffening of the attitude of the authorities, the area protected rising between 1897 and 1907 from 1,856 square miles to 8,153 square miles. In 1905 Troup in Tharrawaddy carried out some enumerations which seemed to show that the younger teak age classes were more numerous in burnt areas of teak forest than within the protected areas. Beadon Bryant, the Chief Conservator in Burma, took up the matter and drafted a memorandum, in which he suggested that fire protection should be abandoned in a certain type of moist forest. The Inspector-General was unable to agree that the proposals should be brought into force at once, but advised that experiments should be carried out in each circle or division. This suggestion was adopted. By 1911-12 the area fire-protected had dropped to 6,750 square miles. After the lapse of a few years the general opinion of Burma forest officers was that fire protection in the moist forests, owing to the dense growth of evergreen shrubs, soft wooded species, etc., which grew up preventing the young teak from developing, was a mistake. After a visit the Inspector-General, Sir

George Hart, recommended relaxation in fire protection. In 1913-14, 4,548 square miles were protected at a total cost of R.200,583. By 1923-24 the area protected had fallen to 142 square miles, at a cost of R.16,731. The present policy is generally to confine protection to regeneration areas and to areas where it is known to be beneficial and financially justifiable. The Burma observations resulted in officers in the moist *sal* forests of Assam and Eastern Bengal (Duars) studying the matter, and much the same conclusions were arrived at, In areas long fire-protected there was a dearth of the younger age classes, whilst the floor of the forest had become covèred with a dense and worthless evergreen growth. The matter, in another form, spread throughout India. During recent years the method of early burning of forest areas in which the fire would cause little damage has been introduced, thus reducing the area actually protected. Its advocates maintain that unless protection from fire can be completely assured and the expense of such protection be justified, it is better to fire the areas departmentally early in the season as soon as the grass, etc., is dry enough to burn than to risk the forest being burnt in the hot weather when the fire is much more severe and the probability of damage greater. In their last two quinquennial Reviews, between 1909-10 and 1918-19, the Government of India have been, perhaps naturally, somewhat guarded in their remarks on the new departure, cautioning the forest officer against entering too lightheartedly upon the new procedure, which thus rids him of one of his most arduous duties in the hot weather. To date it may be certainly said that the Department has not needed the caution, and, so far, the departure, where it has been carried out, appears to be meeting with success. Further, it may prove a possible aid to sylviculture and the regeneration of certain types of forest. I should like to have considered this most interesting question at greater length, but space precludes the possibility. It will, however, crop up in my remarks upon the work in the Provinces, to which we will now turn. I will take them in the order of my tour this year.

As an introduction it should be stated that the method of working the forests for many years was by the so-called selection system and so-called improvement fellings. In practice what happened in the course of years was that many of the large-sized trees of the few species which were marketable were gradually removed, leaving numbers of hollow or badly shaped trees in the forests, not worth removing, mature unsaleable species, and younger age classes which were very far from being normal. The craze for revenue, shortage of staff, etc., was responsible. A realization of the true position of affairs now pervades the Department as the following brief notes will depict.

Bengal.—The chief progress made in Bengal, and it is considerable, is in the northern forests. For years the question of obtaining satisfactory regeneration in the forests, both in the Darjiling Hills and in the Duars

Forests at their foot, had proved an enigma. In the hills the gradual removal of the larger part of the seed bearers of the valuable species led to a working plan based on artificial regeneration, the success being poor. In the plains *sal* forest it was at length realised that fire protection had resulted in the introduction of a dense evergreen growth which prevented the *sal* seedlings getting up. Various attempts were made at artificial reproduction at considerable expense and only moderate success, and then the *toungya* method was started on a small scale in Jalpaiguri Division in 1908 and subsequently on a larger scale in 1914. Mr. Russell had independently started successful plantations in the same manner at the Cinchona Gardens. This method, adopted in Burma years before, is to clear-fell and grow agricultural crops for two or more years, the cultivator putting out the young tree seedlings provided by the Department or sowing the seed at the stipulated time. The method met with instant success and is now practised in Kurseong, Jalpaiguri and Buxar Divisions, etc. These concentrated methods of regeneration pre-suppose sufficient labour, a demand for the material from the clear felling and adequate extraction methods. The operations at Sukna will be briefly described. A first consideration was a nursery, and here Bengal had the great advantage of having the Cinchona plantations in the province. Nursery work here had been reduced to a fine art, and the Bengal forest officers had the benefit of the advice of Mr. Russell, the Officer in charge. In consequence, when Blanford, from Burma, came to see (in 1922) the successful *toungya* plantations formed at Sukna, mainly since 1918 (for the real start dates from then), he returned to his province and said that the Bengal nursery work was the best he had seen, and paid Bengal the compliment of copying their methods. *Sal* is not the only species being used in the Kurseong Division. Others are *Gmelina arborea*, *Chikrassia tabularis*, *Bischofia*, *Terminalia myriocarpa*, *Bombax* and *Artocarpus*. At first the species used were put out in a hap-hazard fashion, but the soil factors are now being considered, so as to avoid having large areas of pure plantations. I saw some wonderful young crops of one year old *sal* sown six feet apart (three rows of seed 4in. apart) looking like a crop of tea bushes, so good had been the regeneration. The material from the clear felling is collected to a centre by a skidder and then loaded into trucks and taken to the Darjiling Himalayan Railway on a side line, which that railway constructs free of charge into the coupe. A small sawmill is in existence and a larger one is to be set up at Siliguri. These plantations have to be fenced with barbed wire in order to keep out deer, wild pig, etc.

Up the hill at Toong at an elevation of 7,000 ft. is situated a sawmill reputed to be the highest in the world. The same method is practised here, the logs are drawn to the mill by a skidder, sawn into planking and then sent down a wire ropeway 1,000 ft. to the railway and cartroad. The success of the work here is due to Shebbeare, Conservator, W. E. Hodge, Divisional Officer,

and G. W. Houlding, Forest Engineer. Some of the men working here are old porters of the last Everest Expedition, and are ready to set out on the next one. Shebbeare was himself a member of the last expedition. The chief species being planted up here are Utis (*Alnus nepalensis*), Pipli (*Bucklandia populnea*), Walnut and *Cryptomeria japonica*. At Takdah, in the Darjiling Division (5,000 to 6,500 ft.) *Cryptomeria japonica* plantations are being made in the same fashion, all planting since 1919 having been done free by *toungya*. No weedings are necessary.

The formation of plantations by the *toungya* method was not new to Bengal. In the early seventies of last century teak plantations had been formed at Kaptai on the Karnafuli River in the Chittagong Hill Tracts. These were destroyed by a cyclone in 1897. In recent years they have been recommenced.

Assam.—The show division in Assam for some time past has been Goalpara situated to the east of the Buxar division, which includes some of the finest *sal* forest in this part of India. In the past the difficulty of exploiting the *sal* was due to the absence of water in the forests. The building of a short length of tramway by Perrée in 1905, helped to solve this difficulty. In recent years this line, which started from Kochugaon into the forest, has been lengthened and converted into a steam tramway. The line now runs 17 miles through the open country to connect with the railway, and there are many miles of branches into the forest where exploitation is in full swing. In 1906 there was only a mud thatched roof hut at Kochugaon. Now there are a dozen good bungalows for the staff, a post-office has arrived, and a sawmill and engine sheds have been erected. The whole of this work has been undertaken by the Department, including the building of some difficult bridge work over the rivers. Messrs. Meiklejohn and H. P. Smith have been responsible for a good deal of the recent work which has transformed this rather remote spot. Concentrated regeneration by *toungya* is being commenced here. It is also in force in Sylhet and Cachar, where some excellent work has been carried out in the past five years. In fact, the great extension of this type of regeneration dates from 1919 in most provinces, except Burma.

Burma.—It has been mentioned that the *toungya* method commenced in this province, having been suggested by Brandis when he was in charge of Pegu between 1856-62. For years teak plantations were formed in this fashion, but without any co-ordination; thus many got lost to sight and were never thinned. In 1905 in Pegu, Lace drew attention to the position, and as a result Government practically put a stop to this practice in 1906, improvement fellings of a more advanced type being prescribed. The first attempt in Burma to work a forest under concentrated regeneration was made in the Katha Division. Since natural regeneration was not obtained readily, resort was made to artificial *toungya* work. It was

recognised that when seed bearers were insufficient, artificial regeneration would become necessary to obtain complete stocking. The work carried out here was of value since it taught the forest officer the value of regulated *toungya*. The general return to *toungya* came in with the Tharrawaddy Yoma Working Plan in 1918, and has spread to other divisions. The rapid extension is indicated by the fact that on June 20th, 1924, the area of *toungya* plantation was 98,740 acres, showing an increase of 20,000 acres in the preceding six years, as compared with an increase of just over 1,000 acres under *toungya* plantation in the preceding eleven years. Teak is not the only species utilised. At Tharrawaddy *Xylia dolabriformis* (pyinkado), *Terminalia tomentosa* and *Pterocarpus macrocarpus* (padauk) and several others are put out. Mr. H. R. Blanford, now Conservator of Working Plans, has been responsible for much of the recent work here, and in his company I saw some magnificent young crops last February. This division, with Zigon and Prome, is worked departmentally and the material is sent down to Rangoon, where it is dealt with by the Utilisation Conservator, Mr. W. A. Robertson. The latter is an expert in Utilisation and has a fine sawmill, seasoning plant and workshops in Rangoon. The transit of the teak logs has been greatly facilitated by the river training works instituted by Messrs. F. A. Leete, C.I.E., and G. C. Cheyne, which have confined the streams to definite beds on leaving the hills. Another remarkable piece of recent work carried out in Burma has been the inauguration of aerial forest surveys. Two such surveys have been accomplished—the first in 1924 for the Irrawaddy Delta forests and the second (1925), a more difficult undertaking, for 1,400 square miles of unexplored forests in hilly country in South Tenasserim. The idea originated with Mr. E. F. A. Hay, I.F.S., but it was Mr. H. W. A. Watson, now Chief Conservator, who pressed the Government to make the attempt. Success has been achieved in a remarkable manner.

Bihar and Orissa.—In three of the Chota Nagpur (Singbhum) Divisions, Saranda, Kolhan and Porahat, the regeneration of *sal* presents no difficulty over considerable tracts. The system now applied, formerly termed the Uniform System, is in reality Clear Felling. The old *sal* crop is felled, clumps of good young poles being formerly left when present. The modern procedure is to cut out the poles and then burn the area in early April. The prolific young *sal* regeneration is burnt down, but the roots are not killed, and strong shoots are sent up from beneath the surface. Mr. Nicholson, the Research Officer of the Province, with whom I inspected the method, states that an even dense crop of young plants, seedlings and coppice, is thus obtained. In Sambalpur parts of the forests are worked under the coppice system with excellent results. There is also an excellent example of the Strip System.

Central Provinces.—The Raipur *Sal* Forests, which are to be opened out

by a new 2ft. tramway and for which a new working plan is in the press, are to be worked under the Uniform System, natural regeneration being abundant. With this exception, and an area of *Pinus longifolia* plantation which is showing remarkable growth, the Central Provinces forests are worked under the Selection System. Sir Henry Farrington, Bart., the Chief Conservator, has within the last few years placed the Improvement Fellings on a proper basis, each coupe being now thoroughly worked out and the necessary thinnings carried out before being left. Some of this work is now departmental. There is little doubt that the forests have greatly improved since Sir Richard Temple's day, but progress has lagged behind. In Farrington's company I visited the fine Allapilli Teak forests, which have been known for a century. The improvement felling and thinning work in one working circle and the exploitation of the fine teak in the other proved most interesting. The latter has to be carried out with care since the logs have to be carted 80 miles by road to the depot and sawmill at Ballarshsh on the railway. The organization of the Allapilli scheme is a good example of modern developments.

Madras.—There are several interesting studies to be made in Madras. The Gumsur *Sal* Plan is reminiscent of the method of working the *sal* forests in Chota Nagpur, except that having removed the old growing stock and burnt the refuse, the young regeneration is then cut back so as to obtain an even dense young crop. The famous Nilambur Teak Plantations are worked on the clear felling and artificial restocking method. There are one or two problems here. The chief perhaps—Will a second rotation pure crop produce as good results as the first now being cut, and would it not be better to interplant or underplant with a species such as *Hopea*?

The most interesting place to visit in Madras is the Palghat evergreen forests up to recently regarded as inaccessible to exploitation. A sawmill and seasoning kilns (to season the soft woods) have now been erected at Olavakote on the railway, and in the forests some eight miles away in difficult hill country the marketable trees, some of gigantic dimensions, are being felled. The exploitation works here are most up to date. Broad roads, beautifully graded, have been driven up the Sappal Valley to near its head, an upper and a lower one. By using powerful tractors, skidders and gyn poles, usually trees selected at definite spots along the roads, the logs are hauled up on to the upper road or down to the lower one. The great schemes in force here were inaugurated by Messrs. S. Cox, C.I.E., and H. Tireman, C.I.E., Chief Conservators, and the wonderful way they are being worked is due to Mr. Martin, Chief Forest Engineer and Major Chipp, D.S.O., M.C., who is in charge in the forest. A *Terminalia tomentosa* felled had a diameter of 7 feet at the point of junction of two branches: The lower log weighed 10 tons and contained 280 cub. ft. The two logs above the fork contained respectively 160 cub. ft. and 120 cub. ft. These logs were yarded up a slope

of 22°! Other valuable species here are *Mesua ferrea*, *Hopea parviflora*, *Dysoxylum malabarica* and *Artocarpus hirsuta*. The regeneration of this type of evergreen forest requires some overhead cover. Present experience seems to show that when all marketable trees have been cut out, and only such are felled, the cover left is sufficiently heavy to protect the young regeneration. This latter is either natural, if sufficient valuable species are present in the overwood, or is assisted artificially. An adequate description of the fine work being carried out in these great forests would require a paper to itself. The work is all under the strictest supervision, stock maps are available for each compartment worked in, and daily records and commercial accounts are kept. Tireman and Minchin have studied the sylviculture of the Coorg forests which are similar in character and are also being worked.

Bombay.—In the North Kanara Teak forests a somewhat similar exploitation scheme is in force under Mr. A. C. Hiley, though not on the same colossal scale. The tractor is a Fordson, and in one place the American device of a buffalo-winch is in use for hauling logs on to the road. Under Mr. Pipe, Superintending (Forest) Engineer, a co-ordinated scheme of roads and buildings has been devised; the sawmills in the province are all under his charge, and in the North Kanara working area at Dandeli he has probably one of the largest and most replete depots in the Forest Department in India, with workshops, drying sheds, store rooms, etc. Another point of interest is the present management of the forests which are not capable of producing large-sized teak timber. During the earlier part of the century and until comparatively recently these had been managed as Coppice with standards. Areas of this kind exist in Thana, Belgaum and Dharwar. The procedure now is to treat them as pure coppice on a rotation of 40 years, the better types of forest being on an 80-year rotation. After clear felling, the material remaining consisting chiefly of brushwood under 6in. diameter (above that size is converted into charcoal) is spread out in patches and burnt; only these patches are either sown with teak seed or planted up. This supplements the crop of teak coppice shoots coming up from the stools, which are carefully trimmed. The demand for the coppice coupes is large and the contractors thus readily undertake to carry out the rules in force on the subject of exploitation and cleaning, etc., in the coupe. The work seen here in company with Mr. A. G. Edie, the able Chief Conservator, Mr. Newman, Conservator, and Mr. E. A. Garland, Divisional Officer, merits high praise.

United Provinces.—These provinces took the lead in breaking away from the old selection system and introducing regeneration under the Uniform System and also coppice with standards. They were also the first to introduce experimental thinning of bamboo clumps. The regeneration of the deodar for years gave difficulty, but the Uniform System is in force in the hills both here and in the Punjab and intensive working plans exist, some of

the best in India, for the Himalayan forests of deodar, blue pine and the *Pinus longifolia*. In the Dun forests the Uniform System is in practice, but the new crop, obtained with success, is really a coppice growth under a shelter wood. When all material has been removed the refuse is burnt in April and the new crop comes up during the next rains. The amount of overhead cover to leave is still in doubt. And this is even more the case in the fine *sal* forests of the Terai divisions of Haldwani and Ramnagar. Since 1914, when Collier introduced the Uniform system into the Haldwani Division experiments have been taking place here in which Collier, Troup, Trevor and Smythies have all taken a hand. The difficulty experienced is that if the cover is opened out too early a dense weed growth supervenes and kills out all the young natural regeneration of *sal* which, only a few inches high, thickly clothes the forest floor. If the cover is kept dense the *sal* persists but does not grow. Frost is the danger here, and, therefore, clear felling is impracticable. An effort was made to weed in the rains. The malaria is. however, so bad that most of the gang engaged died before the ensuing cold weather was over. Early burning or a double burning, the first to get rid of grass and a second as soon as the leaves are on the ground, is now being undertaken by Smythies. So far certain success has not been achieved. It was suggested that annual early burning for five successive years before regeneration was required might destroy the weed growth sufficiently. A tramway has been laid down in this division to facilitate the extraction of the timber, and has just commenced functioning.

A division which has achieved notoriety is Gorakhpur, the *sal* forests of which produce a very high net return per acre. The system here is clear felling, the resultant crop being coppice shoots. Originally the system in force was coppice with standards—but the fellings in the standards between 1893-1913 were too light and the coppice was suppressed. The 1913-23 clear fellings have given excellent results on areas where there was suppressed coppice or advanced growth. Where this was absent Mr. Wood commenced clear felling with *toungya*. This has been so successful that the 1925 working plan will prescribe a modified system of clear felling to all the *sal* forests of the division. The United Provinces have the honour, on the recommendation of Clutterbuck, the Chief Conservator, of having appointed the first Conservators of Working Plans (1920) and Utilisation (1919) in India. The latter gave rise to the installation of the sawmill, wood working industries and rosin factory at Clutterbuckganj.

A word must be added on the Afforestation Division. This work was commenced on the howling waste of hot ravine lands bounding the Jumna and stretching from Cawnpore to Agra and away to the east. The lands had become barren owing to the sinking of the bed of the Jumna and the scouring out of the soil into deep ravines during the heavy monsoon rains; the area is swept by fiery winds in the hot weather. It was due to Sir John

Hewett that the attempt to afforest these lands was commenced in 1912, although Mr. Fisher, Collector of Etawah, had planted up an area some years before. During the first few years the work was purely experimental—Mr. Courthope being in charge. By 1919, however, success was assured. A bad famine occurred that year. It was then determined to start work on a large scale and famine relief labour was put on to the work of preparation of the soil, which consists in making embankments and bunds or ridges and trenches. Seed is either sown or root and shoot cuttings made use of. The chief species now used are *Dalbergia Sissoo, Acacia Arabica, Acacia Catechu, Albizzia Lebbek, Butea frondosa* and bamboos. The success achieved is almost incredible, as the slides depict. About 12,000 acres are now afforested and private owners are following the Government's example. Already the division supplies about 44,000 maunds of grass, and, on a small scale, firewood. About 2,300 acres are planted annually. This is perhaps one of the most remarkable pieces of afforestation work that has ever been undertaken, even more remarkable than the planting up of the sandy tracts of the Landes by the French Government, for long considered to be the classic example.

Punjab—The revival of sylviculture in the Punjab was due to Mr. C. P. Fisher who became Conservator in 1907. In the hills the break away from the Selection System was made with the adoption of the Group method in a plan for Chamba. This was unsuccessful and the subsequent plans for the hill forests have been on the Uniform System. In the plains the most important feature in connection with forestry during the past decade and a half has been the great extension of the irrigation schemes and the opening out of the large canal colonies, with the result that large parts of the "rakh" area or waste scrub lands have been made over by the Department for cultivation. In 1894-95 nearly 700,000 acres were under the Forest Department. In 1924-25 the area was only 96,000, 600,000 acres having been made over for cultivation. In their place it has been necessary to make plantations in order to provide for the requirements of the new population. Changa Manga, the first irrigated plantation, now in its 3rd rotation (of 20 years), is suffering badly from a fungus attack (*Fomes lucidus*) which almost threaten sannihilation. Mr. W. E. Fluett, the Divisional officer, is starting *toungya* cultivation in the hope of eradicating the spores from the soil when root and shoot cuttings of Sissu will be made use of. Eucalyptus is also being experimented with. A tramway has been laid down connecting the plantation with the railway, and this greatly facilitates extraction of the material from the coupes. The new plantations now in process of formation are the Chichawatni plantation, 12,000 acres, commenced in 1912-13 (where a tramway is to be built), and Khanewal, 19,000 acres (started in 1916-17) to supply the colonists of the lower Bari Doab Canal. In 1919 Daphar, 7,900 acres, was opened on the tail of the Upper Jhelum Canal. The Tera plantation of 800 acres was formed to provide fuel for the rosin factory. Finally a much larger

project is to be taken up, the Government having promised an area of 30,000 acres in the New Sutlej Valley Irrigation Project which is being investigated. The growth of some of the young crops is remarkable and the value of these plantations both economic and financial promises to be very great. The work of the Irrigation Department in the Punjab, especially the great development of the past decade and a half, is a wonderful achievement and furnishes an illustration of the great work the British Government has done for India. Great stretches of country which were barren wastes a score of years ago are now, in April, covered with golden fields of grain. With the increase in cultivated area other plantations will be required, and it appears as if the important work of the Department in this Province will shift from the hills to the plains. In the hills of recent years considerable improvements have been made with extraction methods and the wire rope has come into far commoner use, Mr. Donald's patent having facilitated its employment. One of the outcomes of the war was the great demand for rosin and the tapping of the *Pinus longifolia* in the immense tracts of this forest, both in the Punjab and the United Provinces, has opened out a great industry, the former having a rosin factory at Jallo.

One of the points which impressed me most in connection with the professional work during my visits to the different provinces was the urgent need of determining generally how the gigantic amount of thinning work in the young crops, now multiplying rapidly, was to be undertaken. By what agency and with what amount of training in this, the most important, as it is the most difficult, of the duties of the forester to be accomplished. This is far too big a subject to enter on here. But it appears that if this work is to be done properly it cannot be left to (in this matter) semi-trained subordinates. In fact it is one of the most important duties requiring the direct supervision of the Divisional Officer. A far larger staff will be required than exists at present if the young crops, let alone the Improvement Fellings and thinnings of the large areas still under the Selection system, are to develop into mature timber of good class and stocking. This is the opinion which was forced upon me. With a few exceptions, the new position which has arisen with the great advance in sylvicultural practice, does not appear to have been adequately realised by the Department as a whole. Yet Indian Forest Officers will readily agree that it is a problem of the first importance.

The progress made in Working Plans during the present century has been considerable. Provinces such as the United Provinces and the Punjab have the greater part of their forests under plans, many of them as well drawn and intensive as those to be found in Continental Europe. Other provinces are not so well advanced, Assam and the Central Provinces being backward in this respect. The Presidencies of Madras and Bombay, when it is remembered that forest conservancy commenced in this part of India, are by no means as advanced as could be expected. Some examples of intensive plans may be

mentioned, one or two of which have been already alluded to. Many plans show the departure from the so-called old Selection treatment with the equally so-called Improvement fellings. We find the Uniform or Shelter Wood Compartment system prescribed in such different types as, e.g., the Kulu Hill forests in the Punjab, the Terai *sal* forests in the United Provinces, the new Raipur *sal* forest plan in the Central Provinces. What may be termed a modification of the system is the prescription to clear fell over existing young regeneration prescribed in the Porahat, Saranda and Kolhan Working Plans in Bihar and Orissa ; and the further modification in the Gumsur *Sal* forests (Ganjan) plan. Concentrated regeneration by the *toungya* method forms the basis of several working plans in Burma and is being followed in Plans for the N. Bengal Divisions, in Assam and elsewhere. Clear felling with artificial regeneration by sowing or planting is the basis of the Thana Working Plan (Northern Circle, Bombay) as also in the Yellapur and Mundgod High Forest Plan, a good burning of the rubbish before bringing in the teak being essential. The Nilambur Teak plantations plan by Bourne is based on similar lines. Coppice plans as, e.g., Sambalpur, Ootacamund plantations and elsewhere and coppice with standards are in existence in many divisions.

In connection with the supervision of Working Plans and other matters of policy it will now be of interest to consider the present position of the Central Government with reference to the Forest Estate in India. Formerly the Government of India decided upon the general forest policy of the country except in the case of Bombay and Madras where they only tendered advice. To understand the present position it will be necessary to review several important acts of procedure. In 1911 alterations in the terms of the then existing provincial settlements with the various Local Governments were introduced. The chief object of these alterations was to convert a portion of the large fixed assignments which most of the provinces then received from Imperial revenues into an additional share of growing revenue. Under this arrangement Forest Revenue and expenditure, as well as refunds, were made wholly provincial. The permanent provincial settlements applied to Madras, Bombay, Bengal, United Provinces, Punjab, Burma, Eastern Bengal and Assam (now Assam and Bihar and Orissa) and the Central Provinces. It is at least open to serious doubt whether the inclusion of Forest revenues in the new policy was a wise step since the holder of the purse is in the strongest position, and there are certain factors in connection with a forest policy for the country as a whole which should remain in the hands of the Central Authority. The Inchcape Committee's report, although it appeared to deal with the whole Department, really only referred to the Headquarters, Surveys, Research Institute, Home Expenditure and the forests of the N.W. Frontier Province, Coorg and Andamans—a mere fraction of the Forest Estate of India. One of their recommendations was the abolishment of the post of Inspector-General in whose place a "Manager with commercial experience in the timber

industry assisted by the necessary technical experts," should be appointed. This recommendation shows a want of appreciation of the true functions of a Forest Department in a country. It is no secret that the question of retaining the post of Inspector-General has been under consideration for some time past. One argument is that as most of the provinces now have a Chief Conservator, an Inspector-General is superfluous. But the former at the most can only usually have experience of two provinces. They could not possess the wide experience of the Inspector-General and they are directly under their own Local Governments. It is said that if the forests became "transferred" in all Provinces the Central Government will have no further voice in their management. Burma and Bombay have already transferred their forests which are now under an Indian Minister. For various reasons neither forms a precedent for the rest of India to follow; and many think it will be a bad thing for the country if the step is ever taken. But even if it were, could the Central Government ever contemplate disassociating itself from the control of general forest policy in a country such as India? The history of most of the Forest Countries of the world furnishes evidence that when a forest policy common to the country as a whole has been absent, sooner or later waste and bad management inevitably supervened, terminated at length by the Central Authority taking charge. The Forest Department control an area of 224,000 square miles of Forest or about 20% of British India. The revenue for 1922-23 amounted to R.5,52,14,000 (approx. £4,247,000) and the Surplus to R.1,84,24,300 (£1,417,000). Decentralization in forestry matters at so early a stage in the new form of Government would at the least imperil the fine work of 60 years and might well spell disaster. Such matters as the control of mountain forests and catchment areas of the great rivers in order to safeguard costly irrigation schemes, power works and so forth, which may be hundreds of miles away in another Province, serve as one illustration. India suffered badly from floods which caused enormous damage both in the north and south during the rains of 1924, directly attributable to excessive fellings in the past in the hill areas. The Forest Budgets are now in the hands of the councils. There is one possible check which a definite forest policy can look to and that is the Working Plan. Here again the history of the past 15 years is disquieting. In 1910 the Royal Commission upon Decentralization made recommendations on the subject of Working Plans in which, broadly speaking, they suggested that the full control then possessed by the Inspector-General should be relaxed, and that only in the case of plans for any "large area," an ambiguous expression when applied to a working plan, should the Inspector-General be consulted, and that the forwarding of Control forms to his office was superfluous. It should be mentioned that with the appointment of a Chief Conservator in Burma in 1905 and later in the Central Provinces it had been decided that the management of all sanctioned plans and checking of control forms should be left to those officers. As a

result of the suggestions of the Royal Commission and proposals of the Government of India submitted to Local Governments for their opinion it was decided that in future in provinces where there was a Chief Conservator the Inspector-General would have no concern with the preparation of Working Plans unless the Local Government desired his opinion. In provinces where there was no Chief Conservator the procedure previously in force would continue. Copies of sanctioned plans would be sent to the Inspector-General and he could point out any defects to the Local Governments. Copies of control forms were to be sent to the President, Research Institute, for use in the Sylvicultural Branch. By 1921 only three provinces, Bengal, Bihar and Orissa, and Assam were without Chief Conservators. In their case the procedure was modified in a letter of October, 1921, which intimated that "all such reports need not, in the ordinary course, be sent to the Inspector-General of Forests. He will always be glad to examine working plans for them if so desired, but reference to him in future will be optional."

In a précis drafted on the past history of Working Plans (appearing in Government of India *Notes—Forests*, June, 1910), the following extract seems to contain the crux of the present position. "The points for consideration therefore are whether the time has now arrived when the Control Check exercised by the Inspector-General may be relaxed partially as the Royal Commission proposes, and whether it is desirable to do so in the present state of forestry in India. The Government of India exercise control over the State Forests through the Inspector-General who is at present responsible for the recommendation to Local Government of *suitable systems of management of the State forests*. If this responsibility is not to be decreased it is evident that every plan should be seen by the Inspector-General before it is approved. The present system is advantageous both to the Local Governments and to the Inspector-General; to the former especially because they will have the varied experience and wide knowledge of the Inspector-General at their disposal, and to the latter because of his responsibility in the matter both to the Government of India and to the local Governments." These sentences were written by a man who had the clear vision of the responsibility of the Government of India *vis-a-vis* the State forests. Has that responsibility been any whit lessened by the introduction of the Reforms? Is it not a heavier burden and a greater responsibility today than was the case in 1910? Until Local Legislatures and the Legislative Assembly itself have become more informed on matters relating to national forest policy can the Central Government deprive itself of an expert on whom they can rely for suggestions and advice? And can the Local Governments do so? The Inspector-General recounted to me in Simla that almost the first step taken by the Bombay Government after the forests were "transferred," was to invite him down to advise them.

The decision on the subject of the post of Inspector-General had not been

arrived at last May. Extensions have been accorded to Sir Peter Clutterbuck in order to give time to come to a decision. To some extent assistance may have been anticipated from the Lee Commission's report. But that Commission appears to have regarded with equanimity the transfer of the forests to Provincial Ministers. But there are Provincial Administrators who by no means take this view. One experienced Governor told me that he viewed such a policy with grave concern. The Lee Commission, he said, included no expert member conversant with the forestry question or the real vital necessity of the forests to a country like India ; nor of the need of a co-ordinated forest policy laid down and jealously guarded by the Central Government. It is I believe correct to say that none of the recent Commissions in India, the 1910 Royal Commission, the Islington Commission, the Inchcape Committee, the Lee Commission (with the exception of Sir Reginald Craddock) and lastly the Muddiman Committee of 1925, included a Member with any expert forestry knowledge. It was with surprise that one learnt that the majority of the Muddiman Committee recommended that the forests should be transferred to the control of Ministers in all Provinces on the plea that the example had already been set by Burma and Bombay, though in neither case has there been time to show the wisdom of the action.

At Simla I had the opportunity of discussing this and other questions with Mr. J. H. Bhore, C.I.E., C.B.E., the very able Secretary, Department of Education, Health and Lands.

How the Government of India was to maintain the necessary control over Forest Policy is admittedly a difficult problem in view of the fact that they have given up the control over finance, and more important still, Working Plans. The problem does not, however, appear insuperable. The idea being considered was the possibility of amalgamating the posts of Inspector-General and President of the Forest Research Institute. This would remove the Inspector General from the Headquarters of Government but in these days of motor cars that would not be a great matter since Dehra Dun is comparatively close to Delhi and Simla. The amalgamation of the two posts, however, would render one of them nugatory. The Inspector-General's function is to tour constantly. That of the President is to maintain supervision over the Research Institute and College. With the recommendations of the Legislative Assembly and Council of State to train Indian recruits for the Indian Forest Service at Dehra it would be more than ever necessary for the President to remain at Head Quarters. It was suggested that if the Inspector-General were transferred to Dehra and made President of the Research Institute there should be a Vice-President in charge of the Institute and College, the extra cost being well worth the object to be gained. These matters are, however, secondary. It would appear of the first importance at this juncture that the Central Government should, after a careful consideration of all the factors coming into play, definitely announce a forest policy

for the future in order that the Local Councils may know exactly how far they can go and where their authority over the forests ceases and that of the Central Government comes into action. It is owing to the vigilant care of the Government of India and the Secretaries of State that this magnificent Forest Estate has been brought to its present condition. My conversations at Simla led me to hope that the Government of India are fully alive to their great responsibility.

DISCUSSION.

SIR CHARLES LOW, K.C.I.E., said he had had some difficulty in following a technical ex-officer of the Forest Department, he himself being a retired officer of the Indian Civil Service. He had spent a good portion of his service in a province which consisted mostly of jungle and he believed it was generally considered very poor jungle, the Central Provinces. When he first went through an Indian forest he had a feeling of intense disappointment at its very uninteresting appearance, but when he began to talk to the *jungli*, who was showing him round, he soon found that it was a great deal more interesting below the surface. He asked the names of the different trees and what they were used for, and every one, apparently, however much alike and however uninteresting their appearance, had a different use. One kind was good for ploughs, another for cart wheels, another for yokes, and, as his guide informed him, others were fit for nothing but burning, and there were some that were good for destroying bugs in beds, and those were much appreciated! The general impression he obtained was that the species differed very much from species in England in that they were all very highly differentiated. They were grown under a tropical sun with different conditions of climate and soil from those of England, and they were put to more various uses, and some of them contained a number of potent drugs or scents. He was brought into rather disagreeable contact with the poison productiveness of one species when a lady tried very hard to poison her husband with something she had obtained out of one of the plants; but curiously enough the Government Analyst, to whom the stuff was sent, could not detect any poison. Some years afterwards he was able to send specimens of the tree to an organic chemist, who discovered that it contained a powerful glucoside which previously had not been known. The possibility of those highly differentiated powerful scents and drugs existing in so many parts of the Indian forests was now beginning to be examined, although he understood that Dehra Dun had had to go slowly in connection with forest products owing to the expense; but, as Professor Stebbing had said, they had spread themselves out on all important matters and probably they were only just in time in doing so from the economic point of view. India for the last few years had been in the position of being very tightly pressed for forest products. It was anticipated that the possibility might arise of India having to provide those needs which her own forests could not supply by going into the world markets in competition with other richer countries and she could only be saved from that by very careful exploitation of her own resources in every possible way. He had noticed how Italy dealt with one of the problems. In the poorest communal forests bundles of firewood were placed on a ropeway, the larger and better-managed ones having strong wire ropes. There were occasional accidents, but nobody appeared to mind, as the people obtained firewood very cheaply. For a great many years the Indian Forest authorities concentrated their main efforts on

limitation and conservation and on local rights, crystallising those rights as far as possible, and making it as easy as possible for the people who lived near the forest and depended very largely upon it for their requirements to get what they required. Therefore, when more modern ideas began to prevail and the Forest Department were allowed to do what might be called economic research and make an attempt to develop what they had in the forest in every possible way, they had a more or less definite property to deal with, and it was as free as circumstances would admit from the troublesome but very proper and necessary, rights. Things were getting better in the way of supply of forest products. He had been asked recently whether he thought there would be a market for woods from the evergreen forests in the south of Chili if sent to India, as sleepers. Even in a province like the Central Provinces, which contained a great deal of wood, he found, when in charge of an Exhibition in 1908, that it paid him better to get Australian jarrah wood from Bombay than to buy the local wood, the condition being that he had to resell as much as possible after the stuff had served its purpose. The importation of wood from Australia into India was not so large as it had been. The sleeper problem was being dealt with at Dehra Dun by the use of preservatives, and the railways made more use of iron and concrete sleepers.

He thanked Professor Stebbing for his brilliant presentment of the manner in which the Forest Department in India were reacting to the present economic pressure, and for the delightful photographs which he was sure would recall to many present the pleasant days spent in various parts of India.

Mr. Walter F. Perrée, C.I.E., congratulated the author on the excellent use he had made of his opportunities. Mr. Stebbing was the first Forest Officer employed on research work, the branch of forest entomology being the first to be created, well in advance of the Forest Research Institute. For years Mr. Stebbing worked quietly and gained a vast amount of information and made a general review of entomology as applied to Indian forests, and the Department had greatly benefited by his work. Many people envied his vast fund of information, and he thought the Department as a whole owed him a debt of gratitude for setting himself the task of recording progress from the beginning up to the present time. The two volumes which had already been published were intensely interesting to all forest officers, and he was sure the third would be even more so. It might, perhaps be inferred from the lecture that progress in forestry was comparatively recent, but he should like for a moment to follow the development of forest conservancy in India. It was started about the middle of last century, and, therefore, had been in existence for some 75 years, a very short period in the life of a forest. In the museum at Dehra Dun there was a section of a deodar tree which was a fine pole when William the Conqueror landed at Hastings. It would be seen, therefore, that the Department had had very little time in which to exercise much influence on the forests of India, but no time had been wasted. The first sixty years were devoted to the constitution of the forest estate. The forests when taken over were by no means all magnificent virgin forests, only a very small proportion being in that condition. The majority consisted of ruined forests in which man, cattle and fire had held sway, and most of the crop was in a miserable condition. Apart from the reservation, demarcation, and survey of the forests, the early professional work of the Department consisted in restoration, and it was a very magnificent work. It was the preparation for what Professor Stebbing had described. Whether or not the progress was the result of the development of forest research or *vice versa* it was very difficult to say, but there was no doubt that when Eardley Wilmot became Inspector-General there was, within the

Department, an insistent demand for better professional work. Attention had then been directed towards doing something of a really technical nature for the forests, and, fortunately, Wilmot came forward. He realised that to achieve that end several things had to take place. First of all he had to reorganise the whole Department, province by province, so as to get the staff and the division of charges in such a condition that the work could proceed. Then he realised that the scientific side had to be provided for in the form of a Forest Research Institute. He was doing for forestry what had already been done for agriculture. Since those days the need for research had been emphasised, principally by the war. Sir Thomas Holland might recollect how he urged the Department to produce more and more turpentine, even at the risk of burning the whole distillery down. The kettles were reduced to the thickness of a sheet of paper, but it was necessary to go on. That, and demands for timber and other products required to prosecute the war, made it clear that the Department had not provided as yet sufficient means for dealing with the problems of the country, and, therefore, immediately after the close of the war they had set to work to deal with matters on a larger scale, and he thought the scheme as it now was would provide for future requirements for some time to come, as it admitted of great expansion. There had been difficulties. Finance had been insistent for the last five or six years, and the programme had to be very much curtailed. When it came to bringing the cost of the work down to a definite figure, sacrifices had to be made, and, with the help of his friend, Mr. Pearson, certain branches were reduced to a skeleton basis, but timber research had to be provided for, and, therefore, they did what they could to maintain the research in timber which, fortunately, they were able to do. Minor products had to go. The branch of minor products would eventually be quite as large as the branches dealing with timber. That the Department had been fairly successful the author had made clear by his remarks voicing the opinion of the Chief Commissioner of Railways. It was most gratifying to the people of Dehra Dun last year to be able to entertain the Congress of Chief Engineers of Railways. There had at times been some friction with regard to the supply of sleepers, but it was only necessary to bring the people together to discuss matters to smooth over all the difficulties. Since that time a Forest Officer had been appointed as a Liaison Officer between the railways and the Forest Department.

With regard to matters of research, in early years little more was done than collecting available information, but research, if it was to be of any use at all, must not only march with, it must anticipate the public and departmental demands. At one time in Dehra Dun they were compelled to obtain much information from outside, but that was not what a Research Institute could tolerate. They had to anticipate things so that anyone who came to the Department could be supplied with the required information. Professor Stebbing had very wisely omitted to deal with the difficult question of forest education. Those in India, especially Indians, would agree that the matter of forest education was as important as forest research. The greater part of the staff in the Upper Subordinate and Provincial Services had been educated at Dehra Dun, but whatever was decided upon must of necessity take a little time. India was now in a state of transition. It was not quite clear what the functions of the Central Government were to be towards local governments and that had to be decided before the other question could be dealt with. He hoped, however, that the wise counsels which had prevailed in the past would continue in the future, and that the forests would not be dealt with purely as a matter of local politics.

MR. RALPH. S. PEARSON said he had not much to add to the author's admirable exposition of the development of the forests in India in recent years, but it might be of interest from the point of view of history to record who was, in his humble opinion, one of the men who did more for the Forest Research Institute at Dehra Dun than anybody else. One of the greatest difficulties was finance. At the critical time of 1913, when the new building was under contemplation, a Revenue Member of the Government of India, Sir Robert Carlisle, fortunately had a very shrewd idea of what could be done with research and helped to obtain the money. The real difficulty was overcome at the time by Sir Robert Carlisle, with the help of Mr. Mercer. When the Department began to have all sorts of visions in mind as to further expansion in 1917 and 1918, the question of money again cropped up. It was a matter of a large sum because it was decided that 1,300 acres were necessary for the Research Institute and Colleges, and on that occasion the Department was greatly indebted to Sir Claude Hill. Fortunately, at the two critical moments when research might develop there were two members who appreciated the efforts of the Department. The author had very rightly said that, generally speaking, research in forest utilisation was roughly divided into three parts: the preliminary laboratory experiments, followed, secondly, if those experiments showed that there might be something arising from the investigations, by larger experiments, and, thirdly, the most difficult business, the translation of laboratory experiments, either small or large, into a commercial proposition. For that purpose it was found very soon that something more than a Research Institute was necessary if the work was to be of real value. Utilisation Circles in the provinces were inaugurated, the first being started in the United Provinces. That at once created a liaison between the work done at the Institute and the various officers actually engaged on utilisation subjects in the provinces, and, also, to a large measure, bridged the difficulty of bringing the Department in touch with the commercial world. There should be a liaison officer between the utilisation circles and commercial circles and the Research Institute. The railways had appointed such an officer, but the provinces had still to do so. The United Provinces had a Divisional Provincial Officer of Supplies, but, owing to want of money, that post had to be abolished. Such officers would be necessary to pass on the information which the actual research officers could not do. Reports were written, but commercial men did not read them.

SIR REGINALD CRADDOCK, G.C.I.E., K.C.S.I., said the two provinces with which he was most closely associated were the Central Provinces, of which he was Chief Commissioner, and Burma, of which he was Lieut.-Governor, and, therefore, perhaps he had had as good opportunities as anyone in India of seeing the work that the officers of the Forest Department did and of appreciating their great value. It was with much reluctance that he was a consenting party to the transfer of forests in Burma to the category of transferred subjects. The local issue was very important there at the time and stressed very strongly, and he found, even among the senior officers of the Forest Department, that instead of opposing transfer there was a good deal of opinion in favour of it. He believed it was generally thought by them that it would be easy to work through a Minister who would probably know nothing about the forests and would be glad to follow any advice given to him! In being a consenting party to that transfer he wished to safeguard himself and the Government of Burma very strongly by laying great stress on the fact that the constitution of India provided that at the end of the ten years' period there might be some retracing of steps as well as a further advance. Forests

were of such extraordinary importance that if the ten years' experience proved that the experiment of transferring them to the control of the Ministers had not been a success, or at least had been accompanied by a distinct loss or failure, the position might, at the end of that period, be very properly reconsidered. He had no late information as to what the opinion of the Forest Department was at that stage on the practical difficulties of working with Indian Ministers in charge, but he had not heard Conservators of Forests and Chief Conservators had found themselves seriously hampered by the circumstances. Forests were not a particularly popular subject, and long views were taken by very few Indian politicians, who were ready to support any demand that appealed at the moment to the popular desire. He had not heard that the step had been in any way fraught with disaster to the forests, and he hoped if they should be proved to be in danger the position would be again considered. As a member of the Lee Commission he would say that they were not concerned with the question of policy in connection with the matter of the reserved and transferred subjects; the Commission had to take things as they found them, and it was not in their terms of reference. Everyone who had been associated with the Indian Forest Service, as he had for nearly 40 years, would agree that in the maintenance of that service a strong European element was essential for the progress and development of the forests and all that they entailed, both to the people who used the produce of the forests, the vast agricultural population, and for the development of India's own commercial products, all those things being of the very greatest importance. Professor Stebbing had alluded to the maintenance of a central establishment with an Inspector-General of Forests. If he was called Chief Forest Adviser, or by some other unobjectionable title, the provinces would probably be extremely ready to invite his assistance and co-operation. He had the greatest admiration for the Forestry Department and for the great work they had achieved in India.

Sir Charles Yate, Bt., C.S.I., C.M.G., said he had listened to the remarks of Sir Reginald Craddock with the very greatest interest, because Sir Reginald had rightly estimated the importance of the Indian Forest Department, and everybody desired to see it strengthened in every possible way. Whether, at the end of the 10 years, a continuation of the policy of dyarchy and transferred subjects would take place, it was impossible to say at the present moment. He himself hoped that, by the end of the 10 years, there wouldbe a united Government again in India, and the question of transferred subjects would no longer be a vital one. He thought two important points could be gathered from the paper: first, that there was a great shortage of foresters in the subordinate department, and, secondly, a threatened shortage at the very top of the tree. The Indian Forest Department had the finest Research Laboratory in the world, and was one of the finest Forest Services in the world, and he hoped England would learn from the Indian Forest Department and put forestry in this country in a better state than it was at present. He should like to know whether, at the present moment, Indian forestry officers were under the Central Government and under the Secretary-of-State for India, or solely Provincial Officers, and their terms of enlistment and services in the uncertain state of some other Provincial Officers. Everyone interested should do his best in putting Indian forestry on a permanent basis as was the case with the Indian Civil Service and all the other Services which were of such great importance.

Mr. R. L. Robinson (Forestry Commissioner) said he had listened with very great pleasure to the lecture, and that Lord Lovat, who very much regretted being unable

to be present that evening, wished to say, on behalf of the Commissioners, how very much those who had to deal with forestry in Great Britain were indebted to the Indian Forest Service for the guidance and inspiration they had given. Although he had no technical knowledge of Indian matters, it was a very great pleasure and duty to follow very closely all matters that appertained to Indian forestry. He thought the Indian Forest Service was the finest in the English-speaking world. That was due to a number of causes, one being the type of man the Service had been lucky enough to get; and the Service had built up a tradition of faithful and ungrudging service. The third point which had led to the advancement of the Service was undoubtedly the spirit of progressiveness, as illustrated by the recent developments to which Professor Stebbing had referred. If those developments were to be carried on, it was necessary to have really first-class men to do the work. The question was, was the Service getting now, and would it continue to get, the type of man, and give the class of training which was essential if the Service was going to be anything but a machine?

Professor Stebbing, in reply, pointed out that the title of his paper was recent progress, and, therefore, it had been necessary for him to confine himself to the more recent work, and the remarks that had been made by the speakers would be very useful indeed as an appendix to what he had said in the paper. He had not touched on Education, because that matter was not settled. So far as he was aware the proposals under consideration when he was at Simla last May had not yet received the sanction of the Secretary of State.

With regard to the question put by Sir Charles Yate, he understood that the Service was Imperial, except in the case of Burma and Bombay, where the forests were transferred, and those Governments in future would recruit members for the Senior Services themselves. He was told that where the forests were transferred, the local governments recruited themselves and that that was not liked very much by men who desired to enter the Service; they would rather be recruited by the Secretary-of-State than by a local government. He had been given to understand that this year the Secretary-of-State recruited the English recruits and the local government nominated the Indian recruits. One or more Indians had been recruited at home and sent out to India, even up to 1925. Until the courses at Dehra Dun were actually functioning, presumably Indians would still be trained in this country.

The Indian Forest Service would read with pride the remarks made by Sir Reginald Craddock. His knowledge of the work performed by that Service is well shown in his Minute relating to the Report of the Lee Commission (p.133). It indicates how truly he appreciates the great value of the forests to India and her people.

On the motion of The Chairman, a vote of thanks was accorded to Professor Stebbing for his interesting paper.

OBITUARY.

George Davenport.—The Society has sustained a real loss by the death of Mr. George Davenport, who was taken ill at the end of October, and died on November 23rd.

His entire life was spent in the Society's service. Born in 1853, he was appointed by his uncle, Samuel Davenport, who served the Society as its Financial Officer

from 1844 till his death in 1876, to assist him in connexion with the concerts at the Royal Albert Hall, which the Society was then conducting. At the conclusion of this work, George Davenport was appointed a clerk on the Society's staff, and he rose to be the Chief Clerk in 1879.

Not long after his appointment the Society purchased a lantern for the purpose of illustrating the papers and lectures read at its meetings. The first was an oil lantern, which was soon superseded by a limelight, and eventually by an electric lantern. Davenport had charge of all these, and rapidly developed very considerable skill in their management, eventually becoming one of the most able demonstrators and users of the electric lantern in its application to the illustration of lectures. He acquired considerable knowledge of electric lighting, and made several minor inventions in connexion with it, including an admirable projection lamp. He also gradually took charge of the various arrangements for illustrating the different subjects described before the Society. In this way he rendered great help to the Secretary, and when he had completed fifty years of service in 1922, he was presented with a cheque for £50 by Mr. A. A. Campbell Swinton, Chairman of the Council, on behalf of the Society, at the annual general meeting of that year. In making the presentation Mr. Campbell Swinton expressed the feelings of the Council in very complimentary terms.

Davenport took a very great interest in the lectures and other functions held at the Working Men's College; he joined the College in his youth and maintained his connexion with it for the rest of his life. For many years he was an active member of the Maurice Rowing Club.

Early in the War Davenport, despite his age, joined one of the Surrey battalions of the new Volunteer force, of which he remained a keen member until the force was disbanded.

Davenport was never married. He died at the age of 72, and although he did occasional work for other societies, he was never regularly employed by any institution except the Royal Society of Arts.

H.T.W.

MOTOR ROUTES IN THE NEAR EAST.

The following particulars regarding the opening up of motor routes in the Near East are based on reports by United States officials in Bushire, Teheran and Alexandria :—

The recent opening up of the Syrian desert and its conversion from a difficult barrier into an important highway of travel and commerce has been accomplished without labour or expense of road building. The little-known desert was found to be a hard gravel highway, ideal for motoring, and by this simple discovery Persia, the Persian Gulf, Iraq, and parts of Arabia have suddenly been brought into close touch with Europe.

Aleppo-Bagdad Route.

This route follows the ancient caravan trail, still used more than any other and principally by natives. It runs from Aleppo east by south-east for about 65 miles to the Euphrates River at Meskene, covering the only part which is real desert and away from water. From Meskene the route follows the Euphrates through Ed Deir, past the Syrian-Iraq frontier at Abulkemal, to Anah, Hit, and Jemail. Near Jemail it crosses the Euphrates to Feluja, and runs east to the Tigris at Bagdad.

The road is very rough and rocky, and although the route is less than 500 miles

long, it requires five days driving. Both the French and Iraq authorities have been working on the road, and out of the six serious obstacles that existed in the spring of 1923—a very bad piece of road west of Deir es Zor and five unbridged rivers—only one remained by February, 1924.

It is planned to make this route passable for heavy traffic by the present summer. As the road follows the river, it is always within reach of water; and as it passes through numerous villages that average only about 10 miles apart, travellers can spend four nights en route in as many villages. About 60 cars a week are using this route, besides numerous cars that run between villages.

BEIRUT-DAMASCUS-BAGDAD ROUTE.

This is the shortest and quickest route between the East and the West. It begins at Beirut, climbs 5,000 feet over the Lebanon Mountains, crosses the valley of El Bika, and passes over the Anti-Lebanon into Damascus, a distance of 107 miles. From Damascus the route runs north-east through Obair and Domeir, then east by south-east across the desert to the Euphrates at Kalaat Ramadi. Melosa, about halfway across the desert, is left 20 to 30 miles to the north of the route, in order to avoid the beginnings of the Wadi Suwab, the Wadi Ali, and a branch of the Wadi Hauran. From Kalaat Ramadi the route follows the south bank of the Euphrates to Feluja, where the river is crossed, and the route from Aleppo is then followed due east to the Tigris at Bagdad.

The road, or surface of the desert, is for the most part extremely good, being hard gravel over which a car can be driven in any direction at almost any speed. There are, however, rough places and depressions in which many springs and axles are broken, and there is troublesome mud for two days after heavy rains. A regular motor service is maintained over this route—a distance of about 550 miles—by a British company.

BEIRUT-DAMASCUS-PALMYRA-BAGDAD ROUTE AND HAIFA EXTENSION.

This route is identical with the Damascus-Bagdad route from Beirut over the Lebanon Mountains to Damascus. It then proceeds north-east 150 miles to Palmyra, where it turns east by south-east and runs 516 miles directly across the desert to Hit, follows the south bank of the Euphrates to Kalaat Ramadi, and there again joins the Damascus-Bagdad route. The total distance is 692 miles.

A transport company maintains a weekly service in each direction. The advertised time is two and one-half days, and the service is conducted with great regularity. Two to four cars are used, which are sufficiently large for passengers and baggage without being so heavy as to sink into the desert in wet weather.

The same company has under consideration the inauguration of a new service by which passengers from Bagdad may travel by motor car, via Palmyra, Damascus, and Beirut, to Haifa, thence by train to Alexandria, boat to Trieste, and by train from there to Calais. By this means Bagdad will be brought within eight days of London.

BAGDAD-TEHERAN ROUTE.

The Bagdad-Teheran route may be covered by either motor car or railway from Bagdad to Khanakin on the Persian border; thence by car. From Khanakin the route passes through Kermanshah and Hamadan to Teheran. The total time required is three to four days. The service is run in connexion with the Beirut-Bagdad routes.

An additional fortnightly service between Bagdad and Teheran was inaugurated in July, 1924, by a British firm in Hamadan. The service connects with the over-

land desert mail service from Beirut to Bagdad, and thus affords a second through connexion between Teheran and the Mediterranean. By means of these through services the journey from Teheran to London has been reduced to 12 days, which is quicker than the rival route via the Caspian Sea, Baku, and Moscow.

SOME FAR-REACHING RESULTS.

The success of the cross-desert services has had the unexpected result of attracting a large number of Indian visitors to northern Egypt. By catching a fast boat from Bombay to Basra, it is possible to reach England in 18 days, via Bagdad, Haifa, and Alexandria; this route appears to be commending itself to many travellers from India, partly on account of the short sea passage and partly, no doubt, owing to its novelty. By taking the Anatolian Railway route from Damascus to Constantinople, it is actually possible to escape the sea altogether from Basra to Calais. Transportation interests in northern Egypt have great hopes of developing the traffic into a permanency; if only as an alternative route, the journey to India overland should have a steady attraction for the travelling public.

The political, economic, and military results from thus linking the East and West will be widespread. Officials can now travel from London to Bagdad in 7 days instead of 22 to 25 days, as formerly. Business men can reach the Persian Gulf from Europe in one-third of the time previously required. Not only is it easier for the East to reach Europe and for European countries to administer Eastern governments, but it has joined more closely together the Moslem world. Muhammadans from Bagdad can confer with those in Egypt within two days, whereas it formerly required 15 to 20 days.

PANAMA COMMERCIAL MUSEUM.

A Commercial Museum was established last year in Panama by an American citizen, in conjunction with three prominent Panamanians. The museum is intended as a permanent exhibition of samples, to which, it is hoped, manufacturers of all nationalities who are interested in Central and South American trade will contribute.

According to the annual report of the British Vice-Consul at Panama City, the organisers of this scheme consider Panama to be the logical centre for such a project by virtue of her unrivalled position as the hub of the great steamship routes of the Pacific and Atlantic Oceans, and it is hoped that by displaying samples of manufactured goods, accumulated from as wide a field as possible, buyers from Central and South America will be in a position to select merchandise and place orders without the necessity of making a journey to the country of manufacture.

With regard to the important question of publicity, it is understood that the museum has compiled a list of ten thous nd buyers to whom it is proposed to mail announcements and other literature, and subsequently to institute a follow-up campaign. Advertisements are to be placed in the newspapers of Panama, Ecuador, Venezuela, Bolivia, Nicaragua, Salvador, Colombia, Peru, Chile, Costa Rica, Honduras and Guatemala. These twelve Republics constitute the territory of the museum.

An option of the entire second floor of a large modern building, situated in the main avenue of the town, and easily accessible from the railway station and docks, has been secured as a site for the museum.

It is proposed to base charges for the exhibition of samples on the lineal foot. The first foot will cost $48 per annum, and for each additional foot $24 will be charged. Each foot may be occupied up to 6 feet in height and 2 feet in depth.

If higher or deeper space is required a slight increase will be made in the charge. Special display spaces for isolated articles and specialities, on tables, in cases, or on the floor, may be secured at the rate of $12 per square foot per annum. The charges above outlined are stated to include publicity, propaganda, the general advertising campaign, announcements of every character, except advertisements in the official organ of the Museum, and individual propaganda.

It is as yet too early to venture an opinion, adds the Vice-Consul, as to the usefulness of this organisation to British manufacturers who desire to enter, or who are already established, in the Central and South American markets. The Panamanian Government has evinced an interest in the undertaking, however, by allowing samples intended for exhibition to be imported free of duty.

THE DANZIG AMBER INDUSTRY.

Although amber and Danzig have been associated for centuries in popular opinion• the amber industry of the Free City of Danzig, which has developed to one of considerable importance and which is carried on at present by seven concerns, is entirely controlled by East Prussia through a State monopoly of the raw product. This monopoly has been in existence since 1899, when the amber rights were sold to Prussia by a Koenigsberg firm for a sum of approximately £800,000.

Amber is found all along the Samland Baltic coast, but, according to a report by the United States Consul at Danzig, the chief source of supply for this region and for the world is Palmnicken, East Prussia, where it is obtained at a depth of 20 to 30 metres from the Prussian State mines. At the State amber works at Koenigsberg it is cleaned and sorted for its various industrial uses and sold to amber goods factories, chiefly in Germany and Danzig.

Raw amber is occasionally found along beaches of Danzig territory, but this is of inferior quality and generally unfit for manufacturing purposes. These beaches, particularly from Weichselmuende to the eastern frontier of Danzig, were recently leased by the Danzig Senate to the Preussische Bergwerke-und Huetten Aktien Gessellschaft, Koenigsberg, for the sum of 9,000 gold marks annually until 1930. Lease rents for the beach from Weichselmuende to Koliebken, the western frontier of Danzig, amount to 1,000 gold marks annually, although it is said that there have never been found more than 2 kilos of amber per annum on this beach.

For a number of years Danzig has been specialising in the manufacture of various types of amber ornaments and jewelry. The value of the output of such articles is estimated at £50,000 to £60,000 yearly, and they are exported all over the world, especially to India, Turkey, Asia, Japan, China, and Jerusalem, where amber is often used for religious purposes in the form of rosary beads. In Africa the natives are partial to necklaces composed of genuine amber beads as large as a man s fist. Ivory and rubber are usually received in exchange for amber ware.

The ground particles, left in the manufacture of genuine amber ornaments, are made into blocks by a special process of heat and pressure. This commodity is produced by the seven Danzig firms who manufacture pure amber articles, and sells at much lower prices.

MEETINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

JANUARY 5th, 1926,—At 4.30 p.m.—MONS. HENRY D. DAVRAY, C.B.E., Chevalier de la Légion d'Honneur, formerly war correspondent for Le Petit Journal in North Africa, "French North Africa."

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 14.. Automobile Engineers, Institution of, at the Chamber of Commerce, Birmingham. 7 p.m. Mr. W. Ferrier Brown, "Sleeve-Valve Engine Development."

Electrical Engineers, Institution of, at the University Liverpool. 7 p.m. Mr. E. H. Shaughnessy, "Post Office Wireless Stations"

At the Armstrong College, Newcastle-on-Tyne. 7 p.m. Lieut.-Col. K. G. Maxwell and Mr. A. Monkhouse, "Recent Improvements in the Insulation of Electrical Machinery."

Geographical Society, Lowther Lodge, Kensington Gore, S.W.7. 5 p.m. Prof. Leon W. Collet, "The Alps and Wegener's Theory."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Dr. Harry Hyman, "Old Metallurgical Books in Glasgow Libraries."

Transport, Institute of, at the Town Hall, Leeds. 5.30 p.m. Mr. H. R. Hepworth, "Roads-Administration and Finance."

Brewing, Institute of, at Engineers' Club, 39, Coventry Street, W. 7.45 p.m. Messrs. H. Lloyd Hind and J. A. Pickard, "The Stream Line Filter and its Application to Brewing and Bottling."

University of London, at Royal College of Surgeons, Lincolns Inn Fields, W.C. 4 p.m. Mr. F. W. Twort, "The Physiological and Pathological Activities and Functions of Bacteria." (Lecture V.)

At King's College, Strand, W.C. 6 p.m. Mr. H. Wickham Steed, "Central Europe and the War." (Lecture IV.)

5.30 p.m. Dr. W. T. Gordon, "Geology and Civilisation." (Swiney Lecture XI.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. Otakar Vocadlo, "From Bohemia to Czechoslovakia." (Lecture VI.)

TUESDAY, DECEMBER 15.. Anthropological Institute, 52, Upper Bedford Place, W.C.1. 8.15 p.m. Captain Pitt-Rivers, "The Inhabitants of Aua Island."

Automobile Engineers, Institution of, at the Engineering Club, Wolverhampton, 7.30 p.m. Mr. W. Ferrier Brown, "Sleeve-Valve Engine Development."

British Empire League, at Egyptian Hall, Mansion House, E.C. 12 noon. Addresses on "Buy British Goods."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. Arthur Honeysett, "Pressure-Boosting Station for the Waterworks of the City of Monte Video."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Prof. S. P. Smith, "An All-Electric House."

Marine Engineers, Institute of, 85/88, The Minories, E. 6 p.m. Mr. J. A. Sim, "Economic Application of the Scott-Still Engine."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. H. H. Featherstone, "Home Kinematography with the Baby Cine-Camera and Projector."

Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Dr. E. H. Griffin, "The Curative Properties of Light and Heat."

Philosophical Studies, British Institute of, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.45 p.m. Sir Frederick Pollock, "The Need for a Philosophy of Law in England."

Transport, Institute of, at Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. R. C. Mayes, "The Organisation and Working of the Royal Victoria and Albert and King George V. Docks of the Port of London Authority."

Statistical Society, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Sir R. Henry Rew, "The International Statistical Institute and its 16th Session."

University of London, at the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "History of Russia before Peter the Great." (Lecture X.)

WEDNESDAY, DECEMBER 16.. Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Sir Cyril R. S. Kilpatrick, "The Development of Harbour and Dock Engineering."

Geological Society, Burlington House, Piccadilly, W. 5.30 p.m. Dr. W. D. Lang and Dr. L. F. Spath, "The Black Marl of Black Ven; and Stonebarrow in the Lias of the Dorset Coast."

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. 1, Mr. I. D. Margary, "The Marsham Phenological Record in Norfolk, 1736-1925, and some others." 2, Mr. C. D. Stewart, "Experiments on the shielding of Raingauges." 3, Dr. H. Jeffreys, "On the Dynamics of Geostrophic Winds."

Structural Engineers, Institution of, at College of Technology, Sackville St., Manchester. Mr. J. Leask Manson, "Factors in the Development of Structural Practice."

Royal United Service Institution, Whitehall, S.W. 3 p.m. Air Vice-Marshall Sir W. S. Brancker, "Air Communications in the Middle East."

Public Health, Royal Institute of, 37, Russell Square, W.C. 4 p.m. Prof. Louise McIlroy, "The Results and Prevention of Puerperal Sepsis."

African Society, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 4 p.m.

University of London, at University College, Gower Street, W.C. 5.30 p.m. Prof. G. E. Smith, "The Wanderings of Early Man."

Illuminating Engineering Society, at 15 Savoy Street, Strand, W.C. 7 p.m. Discussion on Progress in Electric Lamps and Lighting Appliances.

THURSDAY, DECEMBER 17.. Antiquaries, Society of, Burlington House, Piccadilly, W. 8.30 p.m.

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. C. E. Webb, "The Power Losses in Electrical Sheet Material at High Flux Densities."

Linnean Society, Burlington House, Piccadilly, W. 5 p.m.

Mining and Metallurgy, Institution of, at Burlington House, Piccadilly, W. 5.30 p.m.

Mechanical Engineers, Institution of, at Queen's Hotel, Birmingham. 6.30 p.m. Mr. H. F. L. Orcutt, "The Characteristics and Uses of Ground Gears."

Chemical Society, Burlington House, Piccadilly, W. 8 p.m. Informal Meeting.

Tropical Medicine and Hygiene, Royal Society of, 11 Chandos Street, Cavendish Square, W. 7.45 p.m. Sir T. Carey Evans, "The Surgical Aspects of Amoebiasis."

FRIDAY, DECEMBER 18.. Medical Officers of Health, Society of, at the Medical Institute, Windsor Terrace, Newcastle-upon-Tyne. 5 p.m. Prof. H. Kerr, "Industrial Hygiene from the point of View of Public Health Administration;" Sir Thomas Oliver, "Industrial Hygiene from the point of view of the Physician"; Mr. Gerald France, "Industrial Hygiene from the point of view of the Works Director"; Captain J. Robinson, "Industrial Hygiene from the point of view of the Welfare Supervisor."

Transport, Institute of, at the Midland Hotel, Manchester 6.30 p.m. Mr. E. G. Garstang, "Transport in connection with the Fishing Industry."

Aeronautical Engineers, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m.

Mechanical Engineers, Institution of, Storey's Gate, St. James's Park, S.W. 7 p.m. Mr. W. P. F. Fanghanel, "The Work of the Mechanical Engineer in Non-Engineering Industries."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. W. T. Gordon, "Geology and Civilisation." (Swiney Lecture XII.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "Serbia and the Jugo-Slavs." (Lecture X.)

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3813. VOL. LXXIV.

FRIDAY, DECEMBER 18th, 1925.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

DEATH OF HER MAJESTY, QUEEN ALEXANDRA.

A letter addressed by the Chairman of the Council to Lord Stamfordham, on the occasion of the death of Her Majesty, Queen Alexandra, together with Lord Stamfordham's reply, are given below:—

Royal Society of Arts,
John Street, Adelphi,
London, W.C.

8th December, 1925.

MY LORD,

The Council of the Royal Society of Arts beg that you will convey to His Majesty the King their respectful and heartfelt sympathy in the loss sustained by the Royal Family and the whole nation through the death of Her Majesty, Queen Alexandra, whose beautiful and gracious life had endeared her to all classes of the community.

In view of the fact that Her late Majesty was the consort of King Edward VII, who was President of the Society for nearly forty years, and the mother of King George V, who was President of the Society from 1901 to 1910. and is now its Patron, the Council have felt in a very special degree the death of Queen Alexandra, and they desire to place on record their sense of the loss of one whose close connection with the Society they will always be proud to remember.

I am, my Lord,
Your obedient servant,
THOMAS H. HOLLAND,
Chairman of the Council.

The Right Hon.
Lord Stamfordham, G.C.B., G.C.V.O., G.C.I.E.,
Sandringham.

Buckingham Palace,
10th December, 1925.

DEAR SIR,

I am commanded to express the sincere thanks of the King for the message of sympathy in the death of Queen Alexandra conveyed on behalf of the Royal Society of Arts in your letter of the 8th instant.

The King greatly appreciated your feeling reference to the affection with which Queen Alexandra was regarded by all classes, as well as to Her Majesty's special connection with your Society.

Yours very truly,

STAMFORDHAM.

Sir Thomas H. Holland, K.C.S.I., K.C.I.E.,
Chairman of the Council,
Royal Society of Arts.

NOTICES.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, Professor Henry E. Armstrong, F.R.S., will present to a juvenile audience *Alice in Wonderland, at the Breakfast Table.* He will be aided and abetted by Alice, Mac Hatter, The Dormouse, the March Hare, Brer Rabbit, the Cook, the Duchess, Father Christmas and Tar Baby.

The play will be given in two acts, the first on Wednesday, January 6th, the second on Wednesday, January 13th, each day at 3 p.m.

Special tickets are required for these presentations. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to tickets admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

Any ticket holders, who, at any time before the presentations, should find that they are unable to make use of their tickets, are requested to return these to the Secretary as soon as possible.

CANTOR LECTURE.

MONDAY, DECEMBER 7TH, 1925. DR. R. LESSING, Ph.D., F.C.S., M.I.Chem.E. delivered the third of his course of three lectures on "Coal Ash and Clean Coal."

On the motion of the Chairman, SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., a vote of thanks was accorded to DR. LESSING for his interesting course.

The lectures will be published in the *Journal* during the Christmas recess.

JOINT MEETING OF THE INDIAN AND DOMINIONS AND COLONIES SECTIONS.

WEDNESDAY, DECEMBER 9TH, 1925. THE HON. W. ORMSBY-GORE, M.P., Under-Secretary of State for the Colonies, in the Chair.

The following candidates were proposed for election as Fellows of the Society :—

Craufurd, Captain Quentin Charles Alexander, R.N., Lydd, Kent.
Frecheville, Professor William, A.R.S.M., London.
Gibson, George William Edward, Hatch End, Middlesex.
Sclanders, F. Maclure, Saint John, New Brunswick, Canada.
Turnbull, W., Ramsbottom, Manchester.

The following candidates were duly elected Fellows of the Society :—

Finister, Harry, Huyton, near Liverpool.
Hill, A. Glendon, B.A., Ibadan, Nigeria.
Hortor, W. E., Johannesburg, South Africa.
Lloyd, Dr. Stewart J., Alabama, U.S.A.
Nevitt, Thomas Henry, Crewe.

A paper on "The Imperial College of Tropical Agriculture," by H. MARTIN LEAKE, M.A., Sc.D., F.L.S., Director of the College, was, in the absence of the Author, read by ARTHUR WILLIAM HILL, Sc.D., F.R.S., Director, Royal Botanic Gardens, Kew.

The paper and discussion will be published in the *Journal* of January 8th, 1926.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, 24TH NOVEMBER, 1925.

The RT. HON. LORD BLEDISLOE, K.B.E., in the Chair.

THE CHAIRMAN said he esteemed it a very great privilege to be asked to preside that evening over the lecture that was about to be delivered by Mrs. Julia Henshaw, a Director of the National Parks Association, Canada—an Association which, he understood, came into existence some two or three years ago, and which was quite appropriately, in these days of the domination of the other sex, presided over with great efficiency by Mrs. Henshaw. Mrs. Henshaw reminded him that she was only one of the Directors, but he had no doubt that she was the dominant Director! He was sorry to say that Mrs. Henshaw had been very far from well, and he thought it was more than good of her to keep her engagement and to attend before the members that evening. Whatever Mrs. Henshaw said or showed on the screen that evening as the result of her own artistic endeavours, he was going to be rude enough to doubt whether she could really do full justice to her very fascinating theme. During the two-and-a-half months that he himself was travelling last year in North America, he could confidently say that his happiest days had been those which he had spent in Jasper Park, in the Rocky Mountains (thanks very much to the kindness and hospitality of Sir Henry Thornton), Yellowstone Park and the

Yosemite Valley—all National Parks of wonderful beauty, where business and political worries were forgotten, where the eye feasted upon most gorgeous scenery, where the body was braced by healthy exercise in an ideal climate, and where the mind was inspired by the contemplation of the amazing wonders of Nature which were really almost unparalleled ; where flowers and ferns of great variety abounded, and where wild birds and beasts, unmolested by man, sought friendly association with him. He thought perhaps the last feature was the one which appealed to him most—the extraordinary friendliness of animals which had previously been regarded as creatures *ferae naturae*. The Canadian National Parks were real bird sanctuaries, with not even an Epstein panel to introduce an element of discord. There could certainly be no suggestion there of any conflict between Nature and Art, for Nature, virgin and unspoiled, reigned supreme—unspoiled except possibly by those devastating forest fires which alone threw a blight on the most beautiful blend of forest, mountain, lake and canyon to be found anywhere in the whole world.

He was going to make a little confession before introducing Mrs. Henshaw. Upon his return from North America last Autumn, finding himself a humble member of H.M. Government, and feeling that a National Park was a burning need for the body and soul of the British nation, he had at once put up a proposal for the conversion of the Forest of Dean with the adjacent beautiful valley of the Wye, including Symond's Yat and Tintern Abbey, into a National Park for the British Isles. He had been somewhat surprised and pleased at the sympathy with which the proposal appeared to have been received in Government circles. Although the proposal was no doubt reclining temporarily in a pigeon hole, he ventured to hope that, with the stimulus afforded by that evening's lecture, it might possibly emerge and crystalise for the benefit of the workers, and very especially the over-worked brain-workers, of the Old Country.

Canada had been described as the land of promise and of opportunity. There was no country in the world which, in his judgment, more genuinely and accurately answered to that description.

The paper read was :—

THE NATIONAL PARKS OF CANADA (THEIR ADMINISTRATION AND ATTRACTIONS).

By Mrs. Julia W. Henshaw, F.R.G.S., C.de G.,

A Director of the National Parks Association, Canada.

The National Parks—or, more strictly speaking, the great National Forest and Game Reserves of Canada—fall naturally into three categories, first in importance being the vast mountainous park-playgrounds, seven in number, lying on either side of the Continental Divide, covering an area of nearly ten thousand square miles (one-third the extent of Scotland), and bearing such well-known names as Rocky Mountains, Jasper, Yoho, Kootenay, Glacier, etc. To these will shortly be added an eighth Reserve—the Fraser Canyon National Park—which will be traversed by the Trans-Canada Highway. This highway is a paved motor road, already partly constructed, and will one day span the Dominion from the Atlantic to the Pacific, crossing en route five of the parks and opening up immense tracts hitherto inaccessible to the majority. All the major parks are situated among the Rocky and Selkirk

Mountains within the boundaries of the two western Provinces of the Dominion, Alberta and British Columbia.

Then come the animal parks, five in number, where buffalo, moose, wapiti, sheep, antelope, deer and other kindred of the wild are specially protected; though it must always be remembered that animal life is carefully guarded in every National Reserve, the game laws being universally and firmly enforced by Wardens appointed for this purpose, who are trained in game conservation, and possess a technical and practical knowledge of fauna and forestry of a high order. Bands of buffalo, amounting in all to seven thousand head, are rapidly increasing in the various animal parks, and some two thousand wapiti (or elk, as they are commonly called), as well as considerable herds of Rocky Mountain Sheep, are the result of the wise policy of preservation employed there, while the vast quantity of bear, goat, moose, wapiti, deer, sheep, cariboo and antelope that roam the larger parks, of which I shall speak presently, mark these areas as among the finest big game sanctuaries in the world. Naturally such predatory creatures as coyotes, wolves, cougars, lynx and wolverines are kept in check through judicious hunting by the Wardens, but little damage can be laid at the door of this class of animal as they are not sufficiently numerous to constitute a serious menace.

Bird sanctuaries have also been established in certain suitable localities, firstly, because as creatures of beauty, Canadian birds, which are chiefly migratory, returning each spring to the same vicinity to nest and rear their young, demand our special care; and, secondly, because it is highly important for economic reasons to protect those birds which are the natural enemies of the insects which cause damage to crops and fruit. Six new bird sanctuaries were created by Order-in-Council last year, and the Government is now spreading the gospel of bird protection by means of posters and pamphlets. Among the wild birds in the National Parks are duck, goose, swan, grouse, ptarmigan, plover, snipe, loon, heron, pigeon, hawk, grebe, eagle owl, falcon, humming-bird, wren, thrush, wagtail, tanager, sparrow, oriole, swallow, lark and blue-bird, and many others far too numerous to mention. A rather novel idea, and one that should be productive of beneficial results, is the arrangement that Flight Officers of the Canadian Air Board shall report officially upon bird-life; while the scarlet-coated Royal Canadian Mounted Police are honorary Game Officers as well as responsible for the maintenance of law and order within the parks.

The third type of Canadian National Park is the historical one, of which there are two notable examples, namely, Fort Howe in New Brunswick and Fort Anne in Nova Scotia, the former having been closely associated with the earliest history of the Province, while the latter was the scene of the struggle between England and France for the possession of Canada. These historical parks are set apart for the preservation of existing ancient structures, and the policy of the Government in regard to them is designed not only to call public

attention to such sites of patriotic and historical interest as may deserve particular attention, but also to preserve from vandalism, and absorption into private ownership those places where the destiny of the country was once decided.

Outside these three groups of National Parks—the scenic playground, the game reserve and the historical site—thirteen smaller districts have been set aside by the Dominion Government, consisting of certain forested lands, breeding-grounds of birds, and shores of lakes, making in all a total of twenty-seven National Park areas—vast breathing spaces for the people, where waterways, woods and wild animals constitute a kingdom of their own. It may be noted that in addition to the twenty-seven National Parks, there are also many Provincial Parks in the Dominion, beautiful mountainous spots, such as Garibaldi north of the city of Vancouver on the Pacific Coast, and Strathcona in the centre of Vancouver Island, as well as several ordinary scenic Parks in Eastern Canada.

The first Park—the Rocky Mountain, commonly called the Banff National Park—was established by Act of Parliament in 1887, two years after the last spike of the Canadian Pacific Railway was driven in by Lord Strathcona at Craigellachie, as legal phraseology expresses it, "for the *use*, *benefit* and *enjoyment* of the people." That the Parks are "used" is proven by figures, for in spite of the fact that they are nearly all situated in far-western Canada, over 250,000 persons visited them last year. They are of "benefit" physically by reason of the fresh air, healing springs, and opportunities for exercise and recreation proffered there to those who succumb to the spell of Canada; mentally through a care-free camping amid marvellous scenery; and spiritually because there we:—

"Sing the song of all creation,
A brave sky, and a glad wind blowing by,
A clear trail, and an hour for meditation,
A long day, and the joy that makes it fly."

As to "enjoyment," let me draw the picture of but one day, and who will question the deep, breathless, glittering enjoyment of the Rocky Mountains? Can you see the meadows in the soft grey morning swept by dawn winds and silvered with the dew? Booted, spurred and breeched you step out of your tent, a bead-embroidered buckskin coat, which Indian squaws have tanned in the smoke of the poplar tree, buttoned to the throat, as day springs coldly from the caves of night; and with unbecoming haste you seek the camp-fire, where breakfast of bannock baked before the wooden coals, sizzling bacon and that dark brown mystery in a tin pot we call tea in the Rockies, awaits your arrival—then your tent, unlike that of the Arab, is noisily folded away on to the back of an Indian pony, and down the trail you ride bound on another adventure. It may interest you to hear how the tent, food stores, cooking utensils and personal belongings are secured on the pack-saddles,

so that during a long march over stony ground and when swimming the wide rivers, the packs do not slip or fall off the horses' backs. First the articles are piled on and fastened into position with rope; a pack-mantle, or large piece of canvas is placed over the top, and then the Guide "throws" the famous diamond hitch (formed by a series of rope loops, twists and knots) across the load, and secures it in place for the day's journey. It is almost impossible for this diamond hitch to loosen in transit, and every good Guide in Western Canada knows its value when packing ponies, and employs it with dexterity.

It may be that you will follow up the bank of some lovely cataract whose source is a tarn surrounded by massive crags: or, perhaps, mount over a divide where forget-me-nots and gentians, lupins and phlox have woven a brocade so blue that it seems as if the sky had fallen upon the earth—these azure slopes leading on into a little hanging valley filled with yellow mimulus and other water-loving plants. A creek offers you cut-throat trout for lunch, since in the half-hour allotted to the Guide for preparing the mid-day meal you can easily hook a dozen fine fish with a March Brown, and pop them straight out of the stream into the frying-pan. A single day in the Rockies offers a marvellous variety of happenings: sunshine and a world of blossom, or thunderstorms which rend the trees near snow-line from top to base, and set their branches ablaze with electricity. It is very curious to watch the forested ridges burst into flame above the first faint curl of smoke where lightning has struck the tips of the pines with fire, but though a sight gorgeous to the beholder, it is a heartbreaking one to the Fire Wardens, who must wage an unequal battle with the elements.

The Canadian National Parks, with an area as large as Belgium, are administered by the people, for the people, through the one supreme control of the Parks Branch of the Department of the Interior in the Dominion Government. Their ultimate purpose is to offer opportunities for play to all and sundry, and the line of policy along which they are conducted may be summed up in the two words conservation and service. Game, fish and birds, as already noted, are strictly preserved, though splendid hunting, shooting and fishing may be had throughout the immense mountain territory outside park limits; the forests are guarded from fire by a fine system of vigilance and patrol, and a corps of engineers are in charge of roads, trails, bridges, power development, telephone lines, public medicinal baths, water and sewage systems, etc., highly efficient men being also employed as engineers in the field.

No one may purchase land in the National Parks, but leases are granted at a nominal rental for necessary hotel business and residential purposes, all building plans being subject to permit. The Government operates all necessary utilities and facilities, opens up roads and trails, regulates motor traffic, provides and supervises motor and other camping grounds, provides an admirable

Museum of fauna, flora, geology and Indian exhibits, as well as a capital Zoo of Rocky Mountain animals at Banff, conserves all natural resources, ensures health inspection and sanitation in the settlements, regulates by licence all commercial enterprises to provide necessary service for the traveller, and through a Commissioner, assisted by a corps of local superintendents, Fire and Game Wardens, engineers and other officers, administrates every natural asset in these vast natural reserves where the Royal Canadian Mounted Police represent the law. There is a special legal department in charge of the leasing of lands, the supervision of buildings and public health, the drafting of Acts and criminal procedure ; and an honorary Advisory Historic Board, composed of eminent Canadian historians, has been appointed to carry on the work of the Historical Parks section, which includes the preservation of all sites of national importance, and the marking of sign-posts in national development, such as routes of exploration, first landings, first railways, and the birth of Canadian industries, and other notable achievements.

From all this it may fairly be gathered that Canada is leading the world in Park administration to-day. Even the United States, that most progressive of countries, constantly asks our advice on problems we have long since solved. The Canadian Government grants no concessions and no monopolies in the parks, regarding them as main arteries of national recreation through which pulse life-giving stimulation of mind, and strengthening qualities for the body ; and beyond question they exert a healthful influence upon the community, and increase a faculty for enjoyment in the hearts of the people.

In order to guard more securely from commercial exploitation what Dr. T. G. Longstaff declares " is destined to become the playground of the world," the Canadian National Parks Association was called into being, when the integrity of our waterways was recently assailed from more than one quarter. The Association is a watch-dog that neither slumbers nor sleeps—Governments may rise and fall—policies may change—but that watch-dog is of British breed, and what it has, it will hold for the unborn generations of Canada.

Though without doubt the term of Cree origin, Assin-wati, or Rocky Mountain, is very fitly applied to that important part of the Cordillera mountain system which stretches across several of the largest National Parks—since " Rocky," bold, bare, massive, but above all else " Rocky " they undoubtedly are—the ancient name of Shining Mountains, still retained by part of the range north-west of Earl Grey Pass in Kootenay Park, is infinitely more beautiful, and describes to perfection the higher, whiter summits where each head wears a lambent nimbus when bathed in light by the noontide sun or midnight moon. In some parts the mountains are a heaped confusion of crags, in others they resemble the castles of Titans with gay alpine gardens hanging like banners from their battlements, and again you will see peaks with names like trumpet-calls—Wenkchemna, Hungabee, Athabaska, Resplendent, Tekarra, Redoubt—mantled in snow and belted by turquoise and amethyst lakes,

where climbing is fraught with elation, and the courageous fir-trees wage an eternal battle with the wind. Rupert Brooke, the soldier-poet of Gallipoli, found the Rockies "windswept and empty," because, he said, "the ghosts of the past do not haunt them." Surely he was mistaken—they may be called by other names, but there are voices at dawn in the Canadian alpine forests more ancient than those of the Hartz Mountains; Indian shadows that were age-old when Rip Van Winkle went to sleep. There is Ah-ka-noosta, the mighty hunter who learned the secret of perpetual youth from the mountain goat; Wastash-ah the beautiful Cree maiden who rides forever on a piebald pony through the Amiskwi Valley seeking her Indian Brave slain there in deadly combat by Kin-e-ah-kis the warrior; and strange things there are, too, abroad, even in the sunshine of the day.

The discovery of the Rocky Mountains by the White Man occurred as late as 1743, when the emissary of New France, Pierre de la Verendrye, reached the foothills, and then followed in turn Sir Alexander Mackenzie in 1743, Sir George Simpson, the young Governor of the amalgamated Hudson's Bay and North West Companies in 1841, Captain John Palliser in 1857, and all the innumerable explorers, fur-traders, hunters, scientists, alpinists and painters who traversed the area and opened up to us the possibility of National Parks.

As time will not permit us to wander indiscriminately through all, or even the major portion of the Canadian Parks this afternoon, I propose to devote the balance of time at my disposal to the Banff area, which lies along the eastern slope of the Continental Divide, separating the provinces of Alberta and British Columbia, together with the adjacent country outside the park to the north, a region of magnificent scenery beginning at the 49th parallel and stretching up to north latitude 53, covering in all an area of over seven thousand square miles. Between the Banff Park and the vast Columbia icefield, which is over two hundred square miles in extent, lie a series of cloud-cleaving peaks, all over ten thousand feet high, Alberta, Columbia, Bryce, Saskatchewan, King Edward, Diadem Peak and the Dome dominating their lesser fellows, while from out of their ice-bound breasts flow the great rivers of the group—the Athabaska running north to the Arctic, the tributaries of the Columbia swelling that stream on the way from its source in Kootenay Park to the Pacific Ocean, and the Saskatchewan which empties itself into Hudson's Bay—for at the Columbia Névé the Continental watershed reaches its apex and sends forth crystal streams to the four points of the compass. The Athabaska Valley, which runs from one to three miles wide, and affords glorious panoramic views of the ranges—Mount Hardisty, Pyramid Mountain, the Whistlers and Mount Cavell—is unique in that it possesses a special history and a literature of its own. Across the Pass which bears its name a procession of men travelled a century ago in quick succession, leaving in their wake some scattered place-names and a few blazed trees to guide us who follow after. David Thompson, star-gazer and geographer, David Douglas, the botanist,

who gave his name to the enormous fir tree which is British Columbia's glory and the chief source of her timber wealth, the Belgian Father de Smet carrying the Cross of Christ to Kootenay and Cree, and Gabriel Franchère, the renowned explorer, are but four of that picturesque and stalwart band who in their turn were followed by the early fur-traders who journeyed twice a year, in spring and autumn, between Hudson Bay and the Columbia River, the journey occupying over three months, when the mountain solitude resounded with the tramp of men and horses carrying precious pelts, the creak of paddle and the slur of snow-shoe and sled over the skirling snow, as the guttural of Indians rose above the burr of Scottish tongues, and the swashbuckling men of the white and red races trooped over the hills to fame. Last in the bizarre procession came a long line of pioneers, facing privation with dauntless mien that we might to-day enter into possession of our vast primeval heritage, the National Parks of Canada. Many of these men have bequeathed to us priceless diaries and journals, from whose yellowing pages we garner treasures of fact and description which fill the store house of history to overflowing.

Watered by garrulous streams full of cut-throat (*Salmo mykiss*), Dolly Varden (*Salvelinus malma*) and Silver Trout, the Rocky Mountain Parks are also gemmed with lakes large and small, which even on a grey day "hold the sunshine's memory," some vivid green, others purple grey, a few turquoise or beryl, sapphire or jade, in whose depths the Rocky Mountain whitefish (*Coregonus Williamsonii*) lie that eagerly rise to a Royal coachman or professor. The enormous lake trout (*Cristovomer namaycush*), which run up to 60 lbs. in weight are found in Lake Minnewanka in the Banff Park and nowhere else in Western Canada. The chief fish in all Canadian Mountain Park waters are species of Salmonidae.

The Park Administration is successfully carrying on the re-stocking of lakes and streams from the Government hatchery, 600,000 fry and fingerlings having been liberated in the Banff Park waters alone last year, while similar action is annually taken in all the other reserves.

The system of fire protection and fire patrol in the National Parks employed by the Government may be considered under three heads—administrative, experimental and educational. The administrative end is concerned with the drafting of the necessary protective regulations, and the provision of an adequate system of patrols by Wardens, the construction of trails, cabins, and telephones, and the provision of up-to-date fire-fighting equipment, and it includes a system of reports by diaries, which are forwarded by Wardens. Provision is also made for the supervision of all timber-cutting in the parks, and the removal of dead wood and other fire menace, also the thinning of under brush where necessary.

The experimental work is concerned with the investigation of the most effective means of fighting the forest fires, such as the use of wireless, telephones and telegraphs, aeroplanes, gas bombs, portable engines and smoke screens,

and it also takes into consideration the possible economic utilisation of dead timber.

The educational end is in the direction of a campaign to awaken the interest of the public to the necessity for care in the use of fire in the forest. This has involved the placing of fire warning notices throughout the parks, and also on match boxes, tents, axes, and other articles of common use. The loss by fire last year in British Columbia alone is estimated at £800,000, the disastrous result of 1,682 fires, and, as many of these fires were, undoubtedly, attributable to burning forests, these figures will serve to give you a little idea of the imperative necessity for adequate forest fire protection.

So magnificent are some of the forested areas within the National Parks, where pine, spruce, fir, cedar, larch, hemlock, birch and poplar are the principal trees, that from the scenic as well as the economic point of view, the guardianship of these beautiful conifers is a matter of prime importance. It is significant that fires in the mountains, with few exceptions, only date back to the coming of the white man, thus disproving the statement often made that Indians alone are responsible for them. Why should the Stonys, Suswaps and Kootenays destroy their own hunting grounds? The point is ill-taken. Sparks from engines and cigarettes, or neglected camp-fires, are the careless origin of 90 per cent. of the destruction, though lightning is also responsible for a certain number of conflagrations; and since, as is equally the case with the animals and flowers, no laws of preservation can control vandalism unless the public co-operates with official authority to conserve the public's heritage, propaganda and unceasing vigilance are necessary in the parks to prevent destruction. To this end we ask all travellers to co-operate with our splendid mechanical system for fighting fires, which comprises air-planes, cars, tractors, pumps, hose, fireguards, telephones, reservoirs, etc., etc. Last year the Fire Wardens travelled 225,000 miles on patrol in the National Parks.

Once upon a time a poet wrote :—

> " Among the mountains of the Great Divide
> A valley lies in which I long to be."

and in these two lines is expressed all the longing of one to whom the Rockies are comrades. Surely that poet must have been thinking of the Bow Valley when he penned that poignant memory, the valley which is approached by way of open alp lands, where green of a hundred shades is starred with queen-cups, adders-tongues, primulus, dryas, winter greens, and wind-flowers.

Next summer the Trail Riders of the Canadian Rockies—a club of men and women who each year meet on the Western Mountains to take a wonderful two or three days' ride together, camping at night under canvas and winding up the expedition with a marvellous imitation of an Indian Pow-Wow—are planning to ride up the Valley to Bow Lake and thence to the Ptarmigan Country. The Trail Riders welcome newcomers to their ranks, the only necessary qualification for membership being that one must have ridden 50 miles in

the Rockies, and this, of course, new recruits easily accomplish at the first annual meeting they attend. It is a splendid club for those who like riding in the mountains, and already it has a very large membership, including Earl and Countess Haig, both of whom qualified last summer for a Bronze Button, a couple of Indian Chiefs, the man who discovered Lake Louise, artists and scientists, as well as plain humble folk, who simply love to go out on the trails, of which there are 2,000 miles already constructed within the mountain parks, 350 miles of these being in the Banff region. Along such routes it is a joy to ride, past ravines, whose marble walls suddenly compress the vast volume of water into a flood of foam and fret, and then on where the track winds over an arid pass, which disdains to cloak its nakedness with aught save juniper and stone-crop, from whose stony heights you plunge down into a valley so sweet and lush that it seems to wrap the feet of the austere hills in folds of velvet green. Here the Trail Riders find :—

> " Only the virgin quiet everywhere,
> Earth never seemed so far or heaven so near."

Yet their solitude is peopled with delight, the silence spells out a wordless poem, and one is lifted up to the everlasting gates, lifted from meadow-land to mountain-top, till

> " In the awed silence of that dim high place,
> One keeping vigil might not fear indeed
> If it befell him, as that man of old,
> Who in the mountain met God face to face " .

for there in a cirque of snow-crowned crests one comprehends why Moses went up into a mountain to pray, so high above all sordid things lies that country of the blest, in which spirit and soul aspire to spheres where Deity is expressed in the beauty of the world.

Knee-deep in gentians and meadow-sweet you stand, here are asphodel and bergamot, veronica and penstamens to gratify your senses ; the feathery larches in their autumn dress gleam gilt against the sunset sky, and always with inflexible dominion the mountains guard the passes east and west.

Like a shuttle my mind runs to and fro from Banff in the Bow Valley, where is situated the first National Park—which originally covered only 10 square miles, just sufficient to protect the hot springs situated there, but which to-day is nearly 3,000 square miles in extent—up to the headquarters of the Alpine Club of Canada, a charming chalet set on the slopes of Sulphur Mountain, and back to Tumbling Creak, whose waterfalls foam down through narrow gorges or spray out across the rocks and gravelled terraces, to meander later past winding Alpine meadows ablaze with Brown-eyed Susans, hawk-weeds, golden vetches and all the yellow children of the sun. Thus the thread of my thoughts speeds back and forth, weaving a wonderful arras of green forest, blue sky and snow crowned peaks, with here a scarlet knot to mark

the columbines' flaming gauds, and there insets of king-cob embroidered in arnicas and gaillardias that turn the world to gold.

Wild game is plentiful in the Banff National Park, from the wapiti, or great elk, a superb antlered creature, moose, with its ungainly prehistoric appearance, and grizzly bear, down to the little marten and ermine so prized for their pelts.

If you wish to see big game in the Rockies you can either go out camping within the park areas, and observe the goat and sheep, buffalo, bear, deer and caribou with your field-glasses and camera, or you can go hunting outside the park limits and carry a rifle at will. All fire arms of every description must be sealed in the parks, no one except a Game Warden being allowed to fire a shot. Goat are plentiful back among all the ranges, their yellowish-white coats rendering them conspicuous against the herbage of the hill-sides. The Rocky Mountain goat, with his sharp pointed horns curving slightly backwards, weighs from 200 to 250 lbs., and usually measures 35 to 40 inches at the shoulder. He is closely related to the Serow of the Himalayas, and often you may trace his route up the cliff by the tufts of hair torn from his hide by projecting bushes, which serve to mark his trail from crag to crag. He is an inoffensive creature and quite harmless unless cornered, but man or dog are likely to suffer defeat should they come to grips with him, for though slow to anger, he is a very powerful antagonist when roused.

The five principal Western Parks—Rocky Mountain, Jasper, Kootenay, Yoho, and Glacier—are closely adjoining, and are already linked by motor roads or good horse trails, the Crown Circle Road, 500 miles long, which crosses the summit of the Rockies twice, and connects Calgary, Banff, Lake Louise, Windermere, Golden, Cranbrook and McLeod, forming one of the finest mountain motor runs imaginable. In another year Lake O'Hara, loveliest of all the hidden tarns along the Continental Divide, will be reached by car, and, indeed, the completion of the Trans-Canada Highway from Winnipeg down to the Pacific Ocean may be looked for at no distant date. Mountaineering by motor in such a primeval country as the Rocky Mountains has called for the accomplishment of many engineering feats. To penetrate the high-walled canyons, to creep along the rock-ledges and through forests so dense that the road is a mere gash between the trees, all this has taxed the ingenuity and patience of masters of their craft, and it is passing strange to us old-timers in the West to see the ancient Indian trails we once disputed with grizzlies and black bears now widened and graded out of all recognition.

Delightful bungalow camps have recently been built at convenient places along the mountain motor roads, most of them within the confines of the parks, where the scenery is specially fine, and accommodation of the best may be enjoyed. In addition to these charming rest-houses a series of camp-sites have also been laid out where enthusiastic motorists can park their cars and camp in comfort. Last year about 19,000 motorists entered the Banff Park, and this number will be greatly increased in 1926, as additional roads, now

in course of construction, will be completed next summer, and the link between Calgary and Field opened to traffic.

Each National Park possesses some particular asset. Rocky Mountain Park has its marvellous medicinal hot springs and an abundance of big game ; Kootenay Park possesses several hundred miles of motor road through superb and varied scenery, and the distinction of enclosing the tiny lake which gives birth to the Kootenay River out of which stream the mighty Columbia River takes its beginning ; in Yoho Park the Takakkaw Fall leaps down 1,300 feet from between Mount Balfour and Mount Niles, and the Wapta Glacier hemming in the head of the main valley is exceptionally fine. Farther West in the heart of the Selkirk Mountains lies Glacier Park, an entirely different Alpine area, a region of luxuriant forest growth, infinitely greater precipitation (some years the snow fall is 40 feet), and altogether a whiter world in winter, and a greener, gayer country in summer. The flora here is quite different to that of the limestone Rockies, and ferns are plentiful beneath the spreading branches of Thuja (commonly called Cedar), hemlock and fir, and flowering bushes of Goat's Beard and Mountain Ash. To the south, in the Kootenay Pass, Xerophyllum Douglasii or Squaw Grass is abundant, this plant being very local in its appearance and never found in the northern ranges where the shrill voice of the marmot is perpetually heard as he busies himself cutting down grass and flower-stalks with his sharp teeth to spread out in the sun to dry, for the marmot is a gallant little haymaker and a provident housekeeper.

Special mention must be made of Banff, the chief settlement of the Rocky Mountain Park, if only because of the hot springs located there. There are two wonderful medicinal springs in the parks, a quintuple one at Banff, discovered in 1880, and a radium spring at Sinclair in Kootenay Park, the Banff group being situated about a mile apart and yielding 40,000 gallons per hour (approximately 1,000,000 gallons per day) at varying degrees between 85 and 100 Fahr. A few solitary hunters had previously heard tales of the curative properties of these waters from the Indians, who, without doubt, had known of them for centuries past, stories being also rife of rheumatic grizzly bears and other ailing animals coming to bathe in the warm healing pools. When upon investigation the Government found that the springs were all and more than had been described, and received proof of their curative qualities, it was decided to take the region under official control and make these sulphur springs the centre of Canada's first National Park. The first spring discovered was the large lower pool situated in a limestone cave about 40 feet across, and 30 feet high, fed from subterranean sources. This cave, formed by erosion, where the greenish water is from 2 to 6 feet deep, is adorned by shining crystals, huge stalactites and coloured stones. Its gloom is pierced by only a single shaft of light, the water having an outlet through a small tunnel, through which the overflow runs down the hillside, forming a series of small pools caught in rock-basins, and loses itself in a vast marshy meadow, where species

of algæ and myriads of lobilias, mints, ladies' tresses and other orchidacious plants flourish in the warm moisture.

The dissolved solids of the water are chlorine, sulphuric acid, silica, lime, magnesia, alkalis and lithium. The temperature sometimes rises to 114 degrees Fahr. at the upper spring, and the waters possess also a certain amount of radio-activity. The cave has, fortunately, been left unspoiled by so-called modern improvements, only the outer spring having been utilised for up-to-date bathing purposes, a magnificent swimming pool, dressing rooms and wide terraces having been constructed there by the Government for public use. Formerly the only means of ingress was through the small natural opening in the roof, and it was considered a great step towards civilisation when a slender fir tree with slats nailed across it was put down from this hill to the rock ledge inside the pool.

Golf, that apparent necessity of life to-day, has not been overlooked, and very fair links have been laid out at Banff on an alpine meadow, where the surrounding scenery is sufficiently beautiful to claim an occasional glance from even the most hardened patron of the game.

In conclusion, Mrs. Henshaw gave a fine description of alpine climbing in the Canadian Rockies, and wound up by expressing her great indebtedness to Commissioner J. B. Harkin, of Ottawa, for much of the data and statistical information included in her lecture.

DISCUSSION.

THE CHAIRMAN said he desired straight away to express his profound apologies to Mrs. Henshaw for having cast the smallest doubts in his opening remarks on her capacity to do justice to her fascinating theme. There were several ladies and gentlemen of authority and knowledge of the subject present, and he hoped that some of them would take part in the discussion.

LADY PARSONS said she would like to say how immensely the audience had enjoyed the wonderful lecture they had heard from Mrs. Henshaw, and how much they had admired her beautiful slides and pictures. She had been one of those who had enjoyed the privilege of going through Canada last year with the British Association, and on various occasions she had been through those beautiful fields of flowers, pictures of which Mrs. Henshaw had shown that evening. She had on these occasions been able to recognise a great many of those flowers, because she had previously fortified herself with Mrs. Henshaw's book! In addition to the flowers, she had seen and recognised the most beautiful butterflies, which she would not attempt to describe, except to say that up on the glacier at Glacier they had found two of the most resplendent intricate sky-blue moths which anybody had ever seen. She admired the enterprise of the Canadian Government in setting aside those magnificent parks to be the delight and joy of everybody in the future. It had been a wonderful experience for a traveller from the old country to take a walk in one of those parks and to meet coming along a bear, as she had done; to see a pair of egrets building in a tree, and then, coming along in the dusk by the side of the lake, to see the beavers disporting themselves in the water. Mrs. Henshaw

had mentioned with alarm that possibly some of those beautiful waterways might be absorbed for industrial uses. Mrs. Henshaw was quite right, as she herself had heard engineers glorying in the fact that they had taken up one whole magnificent waterfall at Iroquois for the purposes of a pulp-making works, and she thought that they had many other plans for utilising in that sort of way others equally beautiful.

SIR SIDNEY HARMER, K.B.E., F.R.S. (Director, Natural History Departments, British Museum) said he was very pleased to have the opportunity of adding his testimony to the great interest with which everybody had listened to the lecture. It was indeed hard for anyone who had but a few prosaic words at his command to follow on after Mrs. Henshaw's eloquent and poetical lecture. Mrs. Henshaw had emphasized rather specially the advantages of National Parks from the point of view of the tourist and traveller and of the opportunities for recreation which they offered to the people of Canada. Those were objects with which he thoroughly sympathised, but the side of the matter which especially appealed to him was the value of such National Parks as places for the protection of the flora and fauna of the country. It was not so many years ago that we were in a state of great anxiety with regard to the future of the American bison. That anxiety, he hoped, had now been entirely removed. The evidence which Mrs. Henshaw had given of the increase of the number of "buffalo" was, he hoped, an augury for the future security of that species. That was an aspect of the question which must necessarily appeal to every lover of Nature. Owing to its limited size, of course, this country could not have the advantage of National Parks on the same scale for the preservation of animals and flowers, but the London parks themselves were becoming quite an important factor for the preservation of certain animals, and exactly the same thing could be observed in them as Mrs. Henshaw had found in Canada, namely, that the animals therein became quite tame. The wood pigeons and the American squirrels in Regent's Park were quite tame, and one could observe the habits of the ducks in Hyde Park in a way which one would find it very difficult to do in the open country. That was one of the most interesting sides of the subject, and the Canadian Parks' Association and Mrs. Henshaw could be congratulated in the most cordial way for the admirable work they were doing in that connection.

COLONEL SIR CHARLES YATE, Bt., C.S.I., C.M.G., D.L., said he had not been to Canada and therefore had no right to speak on the subject of the lecture, but he did think that all present must envy the people of Canada in having such wonderful and beautiful parks as had been described that evening. He had been very much interested in the Chairman's proposal for forming a National Park in the Forest of Dean. He thought everyone should do their best to support the movement in this country for bird sanctuaries, which were being established in various places throughout the British Isles. We had no great and wonderful animals to preserve, but we could preserve our birds. Whether it was possible to form a National Park such as the Chairman had suggested he did not know, but it was certainly possible to provide bird sanctuaries, and he hoped the movement in that direction would receive every possible support throughout the country.

MR. H. V. COBB, C.S.I., C.I.E., C.B.E., asked Mrs. Henshaw how far it was possible for the average person of average means to get the full benefit of the wonderful parks she had described. Were they merely playgrounds for the wealthier classes, or was it possible for poor people to spend their holidays there?

MRS. HENSHAW replied that since the war a great many developments had taken place along the line of bringing the parks within the reach of as many of the people as possible. One of those developments was the opening of motor roads, so that the owner of any Ford car could drive through the country. Another development was the establishment of motor camp sites by the Canadian Government, where a man, with his wife and family, could put up and make expeditions during the day, returning to the camp at night, at a quite infinitesimal expense. The motorist would bring his pack of food, which he could cook at the central cooking places provided in the camps. The summers were long and warm and dry, and camping out was no hardship whatever. Another development was the institution of bungalow camps by the Canadian Pacific Railway Company, which were very much cheaper than hotels. Eight such bungalow camps were already established and five more were in contemplation. This would mean that in a very few years there would be a chain of such camps through all the main parts of the principal National Parks, enabling people to take a knapsack and walk from one bungalow camp to another, where they could obtain a night's lodging and food at a very moderate cost. These were some of the steps which had been taken during the last three or four years towards bringing the parks within the reach of the average citizen. Under these new circumstances a six weeks' holiday in those parks would cost very little.

MR. JAMES CAWSON said Mrs. Henshaw had referred to the curative springs which had existed in the parks, and he would like to know to what extent the authorities had utilised those springs for the general cure of disease, as in Germany, France, and other European Countries, great discoveries had been made in utilizing the valuable constituents to which Mrs. Henshaw had referred, and the medical profession should appreciate the opportunity of employing them to the fullest extent.

MRS. HENSHAW said that the Banff Springs, which were five in number, were well utilised; the water was piped down into the town of Banff and utilised in magnificent public and private baths and swimming baths, at the Banff Springs Hotel and the Banff hospital, and there were also Government baths. Very extensive baths had also been built on Sulphur Mountain. Altogether she thought it might be fairly said that the springs were employed to their full capacity and that their medicinal value was fully recognised.

THE CHAIRMAN said he had been asked to express the Society's thanks to Mrs. Henshaw. He assured Mrs. Henshaw on behalf of the audience, that they had had a veritable treat that evening. Her lecture had displayed a fulness and accuracy of knowledge, coupled with a command of eloquent and poetic phraseology, which it would be almost impossible to surpass, and it had been accompanied by the most beautifully coloured photographs that he had ever seen put upon the screen. He thought Mrs. Henshaw ought to be congratulated, not merely upon her knowledge and her eloquence, but upon her artistic skill. She had certainly stimulated the imagination to a very exceptional degree, even to the extent, at any rate in his own case, of trying to picture a grizzly bear going to the Banff Spa for his sciatica! He was sure everyone would hope that the present occasion would not be the last upon which they would listen to Mrs. Henshaw's eloquence.

The meeting then terminated.

NOTES ON BOOKS.

A PRIMER OF THE ART OF ILLUMINATION. By F. Delamotte. Second Edition. London: Crosby Lockwood and Son. 6*s*. net.

There has been a welcome revival of the beautiful art of illumination in recent years, and this has led to a demand for an elementary text book, suitable for the use of beginners. Mr. Delamotte's work was designed for this purpose, and the first edition has met with such success that a second and enlarged edition has been called for. The book is divided into three parts: the first is a rudimentary treatise on the history and principles of the art of illumination; the second is devoted to instruction in the practical part of the art, advice being given on such points as the selection of materials, instruments, etc.; whilst the third consists of 22 plates, showing excellent illustrations. All the specimens selected have been taken from well known authorities, and they are excellently reproduced, some of them in colour.

ROADS IN GREECE.

There are almost no roads in Greece and no genuinely effective public demand for them, owing to the country's geographic formation, which has minimised their necessity through centuries. The ample littorals and numerous peninsular tips are the places where population is concentrated, while the interior is everywhere mountainous. No point in Greece is more than 75 miles from the coast, and the Aegean and Ionian Seas have long been the Greek highway from one peninsula to another.

The land highways were constructed 20 or 30 years ago, and have been repaired only once or twice since. Construction is so poor that new roads go to pieces within a few months. In consequence, all roads and highways are in very bad condition, and, except in the larger cities, are little more than trails. Through lack of funds in the treasury of public works, no repair work and only negligible new construction has been done in recent years, outside of larger cities, although the economic necessity of new roads in many localities has become paramount. In the fiscal year 1922-23, according to *Commerce Reports*, there were 22,000,000 drachmas spent for maintenance of roads and 34,000,000 drachmas for making new roads, Old Greece receiving 25,000,000 drachmas. The new roads constructed in 1922 totalled only 80 kilometers. Practically the only construction and repair work since the war have been in the larger cities, especially Athens; but even there the work is slow and painfully insufficient.

Because of this condition of well-nigh unusable roads, motor transport, although of rapid development in the past two years, is greatly retarded and confined practically to city and suburban traffic.

TIMBER RESOURCES OF NORTH MANCHURIA.

The available quantity of timber in North Manchuria, according to *Commerce Reports*, is estimated at 136,000,000,000 cubic feet, of which one thirty-fourth is being worked. The production of timber materials and wood during 1923 as compared with the supply available represents an insignificant amount and is estimated at 200,000,000 cubic feet. Of this quantity not more than one-half reached the market for the requirements of the Chinese Eastern Railway, the cities, and the export trade.

The forest concessions in North Manchuria formerly belonged almost exclusively to Russians. Many of these have now, because of the difficult legal position in which the Russians are at present, been sold or transferred in trust to persons or groups of other nationalities. All of the concessions are situated along the main line of the Chinese Eastern Railway. The methods of production followed are somewhat primitive. The output consists of logs, uprights, poles, sleepers, and firewood.

The preparation of expensive by-products, such as turpentine, rosin, tar, etc., is carried on in small quantities only in the concession areas of the Chinese Eastern Railway. The operation of the forest concessions is complicated by the expense of protection, an important item in view of the unsettled conditions prevailing. During the 1923 season this was estimated to be approximately 5 cents (gold) per cubic foot of timber. The demand for lumber increased after the Japanese earthquake and prices advanced to a comparatively high level.

SANDALWOOD OIL INDUSTRY OF INDIA.

The sandalwood oil industry in India has been of very recent growth, writes the United States Trade Commissioner at Bangalore, and is principally confined to the State of Mysore, which has extensive sandalwood forests within its boundaries. While the neighbouring district of Coimbatore and Coorg are also noted for a fair share of sandalwood production, Mysore has all the advantages incidental to the manufacture ot the oil, being supplied with cheap electrical power. Up to 1916 the State of Mysore, in common with the Madras Government, had been exporting all its sandalwood cut in the area without refining it in the country. The output of sandalwood from these three districts then amounted to 3,000 tons per annum, of which 750 were consumed locally and 250 by the other parts of India. The principal consumer during these years was Germany, which purchased nearly three-fourths of the exports from India, which amounted to about 2,000 tons. Mysore's share of the production amounted to nearly 2,500 tons, Coimbatore and Coorg between them supplying about 500 tons.

Sandalwood oil is required for various purposes, the three principal uses being for perfumery, medicine, and the manufacture of soaps.

During the war when Germany was cut off from the rest of the world, the Mysore Government was getting no revenue from sandalwood exports. In 1916, therefore, two factories for manufacturing the oil were started in the State, one at Mysore and theother at Bangalore City, andoperation onfull salecommenced in 1917. These two establishments are reported to be the largest sandalwood oil producers in the world, with a total annual output of 200,000 pounds of oil. The director of one stated that this output could be increased still further and that the State is now in a position to meet the world's demands for sandalwood oil.

The plantations in charge of the agricultural and forest departments are well cared for and the supply of sandalwood is said to be unlimited, the system of felling mature trees and replanting the cut area being carried on systematically.

Australia and the Netherlands East Indies manufacture a similar but lower grade of oil. The Australian oil, although not actually classified with Indian sandalwood oil, is exported in large quantities to America, where it is used for blending purposes. The Dutch East Indian product, known as "Macassar oil," is equal to the lowest grade of Mysore oil and is also exported in moderate quantities to America and the continent. The Mysore is chiefly exported to Japan, where it is used for medicinal purposes, the other two oils mentioned being of a lower grade and not suitable for either internal or external use.

CHILEAN NITRATE.

The year 1923 was by far the best enjoyed by the Chilean nitrate industry since the disastrous crisis of 1920.

World consumption was approximately 2,170,000 metric tons. This represents an increase of 284,000 tons over 1922 and is practically double that of 1921—though still 386,000 tons, or 15 per cent. below the total for 1913. The European demand for natural nitrate has not been satisfactory for several years, but, according to *Commerce Reports*, a gradual improvement has been discernible for some time, and in 1923 consumption reached 1,100,722 tons, as compared with 1,035,517 in 1922, 655,155 in 1921, and 1,880,722 in 1913. In comparing last year's consumption with that of 1913, allowance should be made for the fact that in pre-war times Germany consumed about 800,000 tons per annum—or nearly as much as all other continental countries combined—while in post-war years it has used only small quantities of natural nitrate. Consumption in the United States—which in the past decade has become Chile's greatest customer—broke all records in 1923. Exact consumption figures are not available, but may be estimated at 900,000, compared with 588,000 tons in 1913. Consumption outside of Europe and the United States continues to increase from year to year, the figures for 1921, 1922, and 1923 being 76,000, 123,000, and 150,000 tons, respectively.

Increased production followed the improved position of the industry. On January 1, 1923, only 55 oficinas or plants out of a total of 150 were working but by the close of the year the number had been increased to 80. This compares with 53 at the end of 1922 and 35 at the close of 1921. Production during 1913 and each of the last three years was as follows: 1913, 2,772,254 metric tons; 1921, 1,315,552 metric tons; 1922, 1,071,797 metric tons; 1923, 1,903,524 metric tons. Since the close of 1923, some 10 or 12 additional plants have resumed operations and the rate of production increased to correspond with consumption.

In 1923, exports reached 2,264,514 metric tons. The figures for 1922, 1921 and 1913 were 1,312,628, 1,113,910 and 2,738,339 respectively.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 p.m.:—

JANUARY 20.—H. HOULSTON MORGAN, Ph.D., B.Sc., F.C.S., President, Oil and Colour Chemists' Association, "Problems in Paint and Varnish Technology." SIR FRANK BAINES, C.V.O., C.B.E., in the Chair.

JANUARY 27.—PROFESSOR JOHN MCLEAN THOMPSON, D.Sc., F.R.S.E., Professor of Botany, University of Liverpool, "Some General Problems of the Transport by Sea and Conservation in Store of Ripe Fruit." (Aldred Lecture.)

FEBRUARY 3.—SIR EDWARD JOHN RUSSELL, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station, "Investigations in Agricultural Science at Rothamsted." THE RIGHT HON. LORD CLINTON, Chairman, Lawes Agricultural Trust, in the Chair.

FEBRUARY 10.—PROFESSOR J. C. DRUMMOND, D.Sc., F.I.C., Professor of Bio-Chemistry, University College, London, "Modern Views of Vitamins."

FEBRUARY 17.—JAMES EDWARD TAYLOR, M.I.E.E., Superintending Engineer, Post Office Telegraphs, etc., South Midland District, "The Propagation of Electric Waves." Admiral of the Fleet SIR HENRY JACKSON, K.C.B., F.R.S., in the Chair.

FEBRUARY 24.—MRS. MARY FISHENDEN, Fuel Research Board, "Domestic Heating."

MARCH 3.—PERCY DUNSHEATH, O.B.E., M.A., B.Sc., M.I.E.E., Chief of Research Department, W. T. Henley's Telegraph Works, Co., Ltd., "Science in the Cable Industry." LLEWELLYN B. ATKINSON, M.I.E.E., in the Chair.

MARCH 10.—REINHARDT THIESSEN, Ph.D., of the Bureau of Mines (U.S. Department of the Interior), "The Microstructure of Coal."

Dates to be hereafter announced :—

C. F. ELWELL, B.A., "Progress in the Radio Art : A Survey of Accomplishment and Possibilities of Future Development."

JAMES PATERSON (of Messrs. Carter Paterson & Co., Ltd.), "Horse Traction and Motor Traction."

SIR JAMES ALFRED EWING, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., Principal and Vice-Chancellor, Edinburgh University. (William Sturgeon Lecture under the Dr. Mann Trust.)

SIR FRANK BAINES, C.V.O., C.B.E., "Preservation of Folk Architecture in this Country."

INDIAN SECTION.

Friday afternoons, at 4.30 o'clock.

JANUARY 22.—COLONEL W. M. COLDSTREAM, R.E., C.I.E., "Indian Maps and Surveys." SIR JOHN O. MILLER, K.C.S.I., in the Chair.

FEBRUARY 19.—SIR MICHAEL F. O'DWYER, G.C.I.E., K.C.S.I., "Religions and Races in the Punjab." (Sir George Birdwood Memorial Lecture.)

MARCH 19, APRIL 16, MAY 14.

Dates to be hereafter announced :—

LADY CHATTERJEE, "Women and Children in Indian Industries."

HERBERT BAKER, A.R.A., F.R.I.B.A., "The New Delhi."

JOSEPH CHARLES FRENCH, I.C.S., "Buddhistic Art in Bengal."

RALPH SNEYD PEARSON, C.I.E., F.L.S., "Indian Forest Products."

DOMINIONS AND COLONIES SECTION.

TUESDAY, JANUARY 5th, at 4.30 p.m.

HENRY D. DAVRAY, C.B.E., Chevalier de la Légion d'Honneur, late correspondent of the *Daily Telegraph* in North Africa. "France in North Africa." The RT. HON. SIR FREDERICK LUGARD, G.C.M.G., C.B., D.S.O., Commandant de la Légion d'Honneur, late Governor-General of Nigeria, in the Chair. The lecture will be given in English.

March 4, May 6.

INDIAN AND DOMINIONS AND COLONIES SECTIONS (JOINT MEETING.)

SIR RICHARD REDMAYNE, K.C.B., M.I.M.E., F.G.S., "The Work of the Imperial Institute."

CANTOR LECTURES.

Monday evenings at 8 o'clock.

H. P. SHAPLAND, A.R.I.B.A., late Editor of the *Cabinetmaker*, "The Decoration of Furniture." Three Lectures. January 18, 25 and February 1.

LECTURE I.—Moulding. Geometric pattern formed by mitreing of mouldings. Invention of waved mouldings. Enriched mouldings in wood and metal. Piercing. Gothic Motifs in early Furniture. Elaborate piercing in

18th Century work. Turning. Split turning applied as surface decoration. Turned bosses used cabochon-wise. Twisting or spiral turning. The double twist. Carving.

LECTURE II.—Veneering. Popular misconceptions as to the process. Saw cut and knife cut veneers. Oystershell veneers. Crossbanding and stringing. Inlaid work. Marqueterie, Black and White effects. Relief Intarsia. Portraiture. Certosina work. Dutch Marqueterie. Gilding. Description of the process. Oil gilding and water gilding. German gilt work. Painting and graining.

LECTURE III.—Lacquering. Preparation of the gum method of application. Damp presses for drying. Prolonged treatment of fine lacquer. European lacquer. The decoration of furniture by the application of leather, needlework, velvet and other textiles. Overlaying with ivory, precious metals and tortoiseshell. The enrichment of Cypress chests. Gesso work. Composition ornament. Sevres and Wedgwood plaques.

G. W. C. KAYE, O.B.E., D.Sc., Superintendent, Physics Department, National Physical Laboratory, "The Production and Measurement of High Vacua." Three Lectures. February 15, 22, and March 1.

W. F. HIGGINS, National Physical Laboratory, "Thermometry." Two Lectures.

CHARLES REED PEERS, C.B.E., M.A., Director S.A., Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." Three Lectures. April 19, 26, and May 3.

LECTURE I.—Definitions. The value and intention of ornament. Prehistoric ornament. Bronze Age. Hallstatt and La Tène. Classic and barbarian art. Lines of communication. Trade and invasion. The Roman conquests. Late-Celtic Art.

LECTURE II.—Roman Britain. The northern invaders. The Christian Mission. Iona and Northumbria. Benedict Biscop and Wilfrid. Offa of Mercia. Alcuin and Charlemagne. The classic revival. The Danes. The Norsemen. Alfred. Athewold and the school of Winchester.

LECTURE III.—Edward the Confessor and the Normans. The Norman Conquest. English Romanesque. The evolution of Gothic art and its use of ornament. The high-water mark. The decline.

DR. MANN JUVENILE LECTURES.

Wednesday afternoons, at 3 o'clock, January 6 and 13, 1926.

PROFESSOR HENRY EDWARD ARMSTRONG, LL.D., Ph.D., F.R.S., "Alice in Wonderland at the Breakfast Table." (Special tickets are required for these lectures.)

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 21..Automobile Engineers, Institution of, at Royal Technical College, Glasgow. 7.30 p.m. Mr. W. Ferrier Brown, "Sleeve-Valve Engine Development."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Major A. G. Church, "The Inter-relations of the British Territories in East Africa."

Transport, Institute of, at the Queen's Hotel, Birmingham. 6 p.m. Mr. C. Owen Silvers, "Passenger Road Transport."

TUESDAY, DECEMBER 22..Colonial Institute, at Hotel Victoria, Northumberland Avenue, W.C. 3 p.m. Captain Edwards, "Naval Yarns of the Great War."

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. C. Hughes, "Fuel Injection."

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No. 3814 VOL. LXXIV.

FRIDAY, DECEMBER 25th, 1925.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, Professor Henry E. Armstrong, F.R.S., will present to a juvenile audience *Alice in Wonderland, at the Breakfast Table.* He will be aided and abetted by Alice, Mac Hatter, The Dormouse, the March Hare, Brer Rabbit, the Cook, the Duchess, Father Christmas and Tar Baby.

The play will be given in two acts, the first on Wednesday, January 6th, the second on Wednesday, January 13th, each day at 3 p.m.

Special tickets are required for these presentations, and these have now all been issued.

Any ticket holders, who at any time before the presentations, should find that they are unable to make use of their tickets, are requested to return these to the Secretary as soon as possible.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

WEDNESDAY, NOVEMBER 25TH, 1925.

MR. R. P. HODDER-WILLIAMS, in the Chair.

THE CHAIRMAN expressed his deep regret that his brother, Sir Ernest Hodder-Williams, was unavoidably prevented from taking the Chair that evening. He had taken his brother's place because Mr. Greenhill was a very old friend of them both.

Really Mr. Greenhill ought to have had an artist in the Chair, and not a publisher. In the matter of colour printing the publisher usually hoped for the best, because he was an optimist; but the unfortunate artist whose picture was to be reproduced generally expected the worst. Mr. Greenhill had been known to satisfy the most

exacting of artists, and that was a very great triumph. Of course, mechanical processes could never reveal the entire spirit of the artist's work. Some of that spirit must be lost in the acid bath, but it was remarkable how little was lost by the best modern process work. On the technical side of colour printing there was no greater expert than Mr. Greenhill. He was an enthusiast and a born experimenter, a gambler in possibilities. Personally, he thought the most interesting possibility at the present time was that of colour photogravure. The more difficult the job the better Mr. Greenhill liked it, and he loved his work. By nature, all printers were alike, and they had a great deal of original sin, but, under the tutelage of publishers and artists, British colour printing had reached a very high level indeed. He doubted whether it was better in any other country of the world at the present time. Mr. Greenhill was one of the pioneers of that triumph, and he was still climbing.

The following paper was then read :—

COLOUR PRINTING.

By DAVID GREENHILL, Director and General Manager, Sun Engraving Company, Limited.

The term, "Colour Printing," embraces so large a field with such variety of method that it is only possible to deal with the subject in a limited way within the scope of this paper.

I therefore propose to deal rather with Letterpress Colour Printing so far as it has developed during the last 30 or 35 years, and more particularly with those branches of the work with which it has been my lot to come, more or less, in direct contact.

Some mention will be made of Collotype and some thoughts will be given on the new developments of Colour Printing by means of Photogravure.

My first experience in connection with Colour Printing was with the famous Wood Engraving House of Dalziel Bros., where, although the general run of work was in fine Wood Engraving printed in Monotone, occasionally work with several colours engraved on wood was done, somewhat similar to the example shewn as Exhibit No. 1 " A Chronicle of England," printed by Messrs. Edmund Evans some years earlier and published by Messrs. Longmans Green and Co., or, rather, Messrs. Longman, Green, Longman, Robert and Green, as they were then.

As will be seen, very effective results of an enduring nature were obtained by this method, both the ink and paper being of a more permanent nature than those now used. One has often felt that sufficient use was not made of these colour wood engravings before process engraving was available.

A very simple and effective method of colour printing suitable for broad effects followed, with line engravings and flat zinc plates etched or cut ; and this process is still practised although it has never been used so much as its merits would seem to warrant. More might to advantage be done by this method, which is quite artistic and effective when carefully used, and I would

call special attention to Exhibit No. 2 giving examples. For this Exhibit I am indebted to Messrs. Hodder and Stoughton, Ltd. I should perhaps mention that this work has been done quite recently, but the method is one of many years standing.

Another step in colour printing by letterpress methods is the endeavour to secure a varying tone whilst still using line etchings.

This is quite easy so far as the key plate is concerned, because the artist draws the lines thicker or thinner, closer together or farther apart, as the case may be, and so gets the varying light and shade of the picture, but with regard to the colour plates used, it is not practical to vary the tone on the drawings for each individual colour, and even if it were possible on the drawing, the separation of same for reproduction by line process would be too difficult. Therefore, various screens and mediums were introduced, the most successful of which is termed the Day's Medium, after its inventor, Benjamin Day. The effect of these screens is to break up the surface of the plate so that it prints in lines, dots, or grains of varying degrees. This method has been used more particularly in the development of cheap toy books printed on rough paper, but whilst it has considerable possibilities, it can only be used to advantage in the hands of the skilful workman or artist, otherwise the result is rough and crude in the extreme.

A common failing with this work is the use of colours far too crude, possibly one reason being that the plates are often made by process engraving houses commonly using three-colour process inks, and the normal yellow, red and blue used for three-colour work is far too frequently used for this colour line work.

These normal colours, although essential to three-colour process work, give very hard and unhappy effects when used separately on line work, and as a general rule it is better to follow in colour line work the shades of colours more often adopted by the lithographer than the colours used in the three-colour process. With care, quite good and useful results are obtainable, both for commercial and pictorial effects. Exhibit No. 3 illustrates this method.

A method used by the House of Dalziel, some 30 or 35 years ago, was quite interesting. I think I am right in saying that they termed it "Acqua-tint" process. It consisted of a method by which an impression of the key plate, which was either a line zinco or a wood engraving, was offsetted on to a series of flat copper plates; the artist then painted out with an acid resist portions of the plate which did not require etching, after which a bituminous dust was laid and fixed which, when etched through, gave a grain with rather nice feeling and character. This dust-grain was varied to suit the different gradations of the work and the job was usually printed with one key plate and about six of these tint plates.

If my recollection serves me well, there were usually a yellow, a buff, a flesh pink, a red, a blue and a grey blue besides the key plate. Of course, sometimes one of the former colours would be dropped out or another one or

more colours added. The results were quite effective for certain classes of work requiring broad treatment and strong colouring such as toy books, but the method demanded very considerable skill in its application and it was probably largely due to this that it went out of use.

When this work was being printed a large proportion of varnish was used to reduce the colours and to make the work dry with a glossy surface, but a defect since revealed is that the great reduction in the strength of the ink by the introduction of so much varnish tended to make the colour less permanent. This was in the days before geared inking arrangements were used and the inking rollers ran loose in what were then called the "roller forks"; on top of the inking rollers steel rods or riders, as they were called, were placed and these helped to distribute the ink on the roller and by their weight tended to keep the inker from jumping. The steel riders naturally revolved very fast and in doing so threw off a most disagreeable spray of the colour in use, so that if pink was being worked, all objects and persons round the machine gradually went pink; when blue was worked all changed to blue and so on. This was not only uncomfortable, but dangerous; indeed, I had my eyes badly poisoned in this way, so much so, that one time the doctors thought I would lose my sight. Fortunately, I quite recovered and, more fortunately still, much better methods now prevail. By the kindness of Messrs. Frederick Warne and Co. I shew in Exhibit No. 4 examples of this Acqua-tint Process and some toy books done in wood line tints, these books being printed about 1890.

Mention must be made of a very interesting process developed and worked for some years by Messrs. Wetherman and Co. of Enfield, by which some very beautiful results were obtained. This method, called Photostone, was worked with a Collotype base and litho tints and a very high standard of quality was reached. I am indebted to Mr. Louis Sommer and Mr. Ward Cox for the following description of this very interesting process:

> "The basis of the process was Collotype and the procedure was as follows:— After taking a negative intended for Collotype a specially prepared emulsion for Collotype plate was prepared, which yielded a grained impression, transferable by means of its grained texture on to stone, zinc or aluminium. A set of spare, medium and full transfers was then taken, from 8 - 12 in number, using as many of the different transfers as were required for the particular job, and adding or eliminating as required. These were then rolled up and proofed in colours in the usual lithographic way. Sometimes, with the better class work a neutral grey printing was included from the Collotype plate, giving the job a special finish. As already stated, the number of printings varied according to requirements. In the case of the two subjects "The Cardinals" and "The Light of the World" about 12 or 13 transfers, also the neutral grey off the Collotype plate were used, and the results speak for themselves.

It might interest you to know that the Holman Hunt picture was reproduced with very great care and that Holman Hunt himself went to the works on several occasions to supervise and discuss the details of the reproduction.

Exhibit No. 5 shews the Photostone process.

Closely allied to the foregoing is the work which is being executed by the London Stereoscopic Co. at their works in New Southgate, but in this instance the method is, I believe, Collotype throughout. This gives very fine results and is particularly suitable for large pictures with short runs. (See exhibit No. 6.)

Messrs. Bemrose and Sons of Derby run a very similar process to this in Collotype; also another process which appears to be a development of Collotype and which they term "Derby Print." With both processes (and particularly the latter) they are successful in producing very beautiful work, some examples of which I am glad to be able to shew by their courtesy. (See Exhibit No. 7.)

An interesting and very bold venture in the matter of colour printing was a method launched some years ago under the name of Wharf-Litho, invented by Mr. Hillyard. In this method large zinc plates were used instead of litho-stones, the image being largely developed by lithographic means, but instead of relying upon the water and grease principle of lithography, all the portions of the plate not required to print were treated by an etching solution which had the effect of graining the zinc, so that it left in relief very tiny points, so small that they could not pick up sufficient ink to yield a visible impression; the work was then printed on letterpress machines by letterpress methods.

It was an extreme development of the idea of the needle-point dot in Half-tone.

A factory for this work was developed and run with very considerable success and some very creditable work was produced, but the more modern and more comprehensive method of three-colour printing, which was rapidly developing at that time, was probably the greatest factor in making it impossible for the Wharf-Litho Process to live. (See Exhibit No. 8.)

The demand for colour printing has led to many efforts in the direction of so called "multi-colour" work, meaning the production of many colours at one operation. I remember quite well a very clever Russian machine and method called the Orloff which was introduced some years ago and which was worked on Rotary principles. It had a series of individual colour plates which were inked by separate devices, and each plate, after being inked, passed under a special composition roller which picked the ink off the several plates in succession, and then relaid the whole of the various coloured inks so collected on to a final key plate, which also contained all the colour areas. One impression was then taken from this plate which yielded the complete coloured result. It will be obvious from this very short description of the method that it was not possible to do tone work, but only lines and flat tints, and the intention was largely to do stamp work, bank note work and label work. Although the whole scheme was very ingenious and the working out extraordinarily clever it did not survive the test of every-day work and commercial requirements.

One of the best efforts made in the direction of multi-colour printing was by means of the Lambert machine. This was a French invention and was in effect four flat bed printing machines combined in one. Each forme-bed had its separate inking device which was equivalent to that of an ordinary flat bed machine, and the sheet was fed into the printing cylinders by means of a very cleverly designed gripper frame, which reciprocated from one cylinder to the next and passed the sheet on for its successive printings with absolute accuracy. On this machine excellent sheets of colour were produced, though perhaps never quite as good as those printed by independent workings of the colours. Astonishingly good results were nevertheless obtained, particularly with four-colour work. The Lambert machine at one time could and did produce a very good average class of colour work on strictly commercial lines, but owing to its limited speed (some 850 per hour) and with the advance of the Miehle Press and the automatic feeder, the method became practically obsolete and faded out.

Exhibit No. 9 shews some examples of the work done by this method, and I may mention that a famous series of popular colour books on art, namely, "Masterpieces in Colour," issued by Messrs. T. C. & E. C. Jack, were very largely produced on this machine. Mr. T. Leman Hare, the editor, and his brother, Mr. William Hare, were mainly responsible for the excellence of the work produced; they took great pains to secure the best possible results whilst the printing was in operation, and a reference to their work will reveal the fact that they stressed very largely the importance of the key, or back plate, being printed full and strong; in fact, they stressed this point far more than is usual in work of this kind. Another work printed on these machines was the reproduction of 100 Pictures from the National Gallery (also published by Messrs. T. C. and E. C. Jack), and of which I shew a sheet. Some work was also executed for Messrs Macmillan and Co. on permanent paper, the results secured being very encouraging.

Multi-colour printing to-day is developing and will, I think, develop even more in the future. The Cottrell four-colour press is used extensively in America for this purpose with results wonderfully good considering the size of work and vast numbers printed; many of the large magazines use this press and method entirely for the production of their colour plates. The machine and plant, however, has so far proved too costly for use in this country, where the numbers printed are so much below the American requirements. On the Cottrell press one impression cylinder only is used for the whole of the four colour plate cylinders, so that individual make-ready and overlaying is not possible for each colour. There has therefore been developed a most ingenious method called the McKay process, by which the electrotype plates are made in relief, i.e., the solids and darker tones stand up in relief, whilst the high lights and lighter tones are slightly recessed, and this gives a final result very closely approximating to what is obtained by individual make-ready for each forme. As will be seen

by reference to Exhibit No. 10, the results are very good indeed considering the fact that all colours are printed at one operation and that very large numbers are printed.

A German machine called the "Iris," made by Messrs. Koenig and Bauer, is making some headway in this country and is more adapted to our British requirements. The Iris machine provides for separate make-ready, and in this respect is better than the Cottrell press, but it is very much slower in production. So far, none of the efforts at multi-colour printing have proved really good for everyday work, although in some cases excellent results are obtained for special work.

Colour printing of to-day is done in the main by lithography, offset and the three-colour process, the latter almost exclusively by letterpress methods, although the photographic principle of the three-colour process is being increasingly used to further and develop offset work and also more recently to develop photogravure in colour.

Without question the greatest development of colour printing in recent years (and particularly of the finer work) has been by the three-colour process. This wonderful and beautiful process relies, firstly, on scientific photography and colour selection, secondly, on skilful fine etching, and finally, on careful, very careful machining or printing. Given these conditions it seems capable of reproducing almost anything in the way of pictorial reproduction in colour.

The treasures of our public galleries and art exhibitions, the water-colour painting, educational, scientific or natural history subjects, flowers, fruits, clothes, pottery, carpets and indeed all the hundred-and-one objects of commerce and art are constantly being reproduced by this astonishingly versatile process. Unfortunately the "pressure of price" is at times responsible for some very poor work being produced and indeed it is a lamentable fact that work of the highest class rarely produces profit in the same way as work less exacting; but notwithstanding the pressure of price, an immense amount of work of a very fair standard is being turned out by this process, and in the case of quite a few well-known firms of a very high average indeed, and fortunately the standard improves.

It is encouraging to note on reference to the work shewn here, the fact that the Britisher is by no means behind others in this branch of our craft. One can, I feel, fairly claim for the British photo-engravers and the British printers premier place in quality for three-colour process work, although our American friends can and do quite successfully contest the premier position in output.

It is interesting to compare some exhibits one has been able to collect from a few countries; examples are shewn from the United States of America, Germany, France—these are certainly our keenest competitors. The work from each is technically good, but none shew the fine attention to detail and finish which British work in three-colour process shews.

The American work displays an excellent average quality considering the

immense numbers usually printed and the stock or paper on which it is worked.

It is probable that the length of run makes it possible for more time and money to be spent on initial costs of original blocks, electros, and fine mounting bases; the Americans attach very great importance to this latter point and spend far more capital than do English firms on the provision of very fine electros and mounting bases, but I do not find in American work that very close attention to the finer detail and shades of colour which distinguish the best grades of British work.

With very few exceptions Continental work by three-colour process is far behind the British standard in quality, particularly since the war; they, no doubt, have found it more difficult to recover.

The general standard of quality of British colour printing has improved immensely during recent years, notwithstanding the difficult period of the war, this being due to the splendid efforts and rivalry between a number of firms of high standing in the printing and process-engraving sections of the industry. Not less important in this direction too has been the wise and persistent pressure of eminent publishing houses, and I would like to pay a personal tribute to Messrs. Hodder and Stoughton, Ltd., to Messrs. Longmans Green and Co., also to Messrs. Cassell and Co., Ltd., for their courage and enterprise in not only launching valuable books demanding the greatest skill and care in the reproduction of the colour work in connection therewith, but also for their wonderful persistence and tenacity of purpose in demanding and insisting on that very high standard of work which, although often difficult of achievement, has always been well worth the effort, and has always tended to raise the standard of British colour printing. I say in all humility and with thankfulness that I am the better printer for this friendly but powerful pressure and that the firm I have the honour to be associated with has spared no effort to improve both its staff and its plant to meet this very right and persistent demand for quality.

I am glad to be able to state that the rivalry between some ten or a dozen firms of high repute in colour printing is so great that there is small chance of the standard of work dropping, rather do I feel it will continue to improve. I have a particular pleasure in calling attention to Exhibit No. 11, it being a display of colour work which is fairly representative of three-colour process work of to-day. I would specially call attention to—

(1) Reproductions of Mr. Archibald Thorburn's Bird Drawings for Messrs. Longmans Green and Co.

(2) The series of colour book jackets for Messrs. Hodder and Stoughton, Ltd., and the reproduction of Mr. Arthur Rackham's drawings.

(3) Reproductions of gallery subjects and of fine porcelain, etc., for Messrs. Cassell and Co.

(4) A range of natural object work for The National Trade Press and others.

(5) The display of larger subjects and sheets for calendars, showcards and other commercial purposes.

Good as the three-colour process is, it, of course, has its limitations and in all directions there is need for persistent effort to improve—

(1) With regard to paper. The finer printed results can at present only be achieved on art or clay-coated paper which lacks artistic merit and is lacking in the very desirable qualities of permanence and toughness.

There is a very real need for a paper which will give the same perfect print of the half-tone dot, and the same brilliance of colour which the whiteness of clay coating so readily yields.

(2) In the matter of ink too, density of colour and permanence are most desirable qualities that need emphasis, and considerable further improvement is required.

(3) As to printing—there is too big a drop on the average of work between the block-maker's proofs and the printed results, although considerable improvement has been made in recent years in this direction. In this connection I may suggest that it would be very helpful if (when a series of colour blocks have to be printed in sheet form) the blocks for each row (usually four) were to be proofed together so as to ensure even strength of inking in each of the four subjects. The absence of this simple precaution in so many cases is, I suggest, responsible for a greater loss in quality than any other single cause.

An encouraging sign of the times is the attention now given to technical education: The London School of Printing and many provincial centres doing yeoman service in this respect.

Colour printing demands not only good technical education but regular practice as well. Much work is spoilt by employees usually on book-work being suddenly and only occasionally put on to colour work, with the result that it is more by luck than judgment if the job turns out passably well. It is increasingly the age of the specialist and particularly so in colour printing.

Very important too is the close co-operation between the process-engraver and the printer. Much work falls short because sufficient attention is not paid to matters of screen, ink and paper. Quite recently on a most important job requiring nearly one million copies printed on a fairly cheap art paper, the three-colour blocks were made with most painstaking care but with a screen 166 lines to the inch, and after many revisions were sent to the electrotypers for duplication, with the result that the printing plates did not yield the desired result. Finally blocks had to be re-made with a slightly coarser screen, etched deeper and the revisions avoided, with the result that the electros then made printed easily and clearly. It is all-important that paper and conditions of printing should be carefully considered when the matter of screen has to be decided. Important too is the point already referred to that many users of three-colour work demand so many revisions and alterations to plates that the re-etching and burnishing required to effect these alterations entirely spoil the printing qualities and render the plates most difficult and sometimes wellnigh impossible for electrotyping purposes.

The general advance of three-colour process printing for commercial purposes has been undoubtedly helped by good electrotyping and good stereotyping. Unfortunately firms doing really good electrotyping are very few indeed, and those doing stereotyping still fewer. There is no doubt with regard to the latter that the Dalziel stereo is of outstanding merit.

I now turn to what is the latest and I believe the most beautiful method of printing yet evolved—Photogravure.

Photogravure has made more rapid strides abroad than in this country, but even here considerable progress is being made and photogravure is established as a practical and eminently useful printing process which is constantly gaining ground, so much so, that great efforts are now being made to develop photogravure in colour and that not without some measure of success.

In America, Germany, Holland, Switzerland, France and England earnest workers and enterprising firms are steadily and persistently working at this problem and the progress already made gives great hope for the future.

An immensely courageous effort in colour gravure was made by the Chicago Tribune people, who made a gallant attempt to produce a large weekly by colour gravure on rapid machines, but although great efforts were made at enormous cost, the attempt was premature and had to be abandoned.

Whilst as yet only in its infancy, colour gravure has already achieved some very beautiful results and at a cost not greatly in excess of good three-colour process by letterpress.

Colour photogravure, although difficult at present, will, no doubt, become more easy to handle as further experimental work proceeds; it promises results well worthy of the efforts already made and still required. It promises, first, to solve the paper difficulty, because it prints readily on beautiful book papers and indeed on almost any uncoated paper, and so permanent papers can be used; secondly, to solve the ink problem, because owing partly to the thickness of the film of ink used and partly to the nature of the colour, the ink is far more permanent; indeed, for all practical purposes it is permanent. And, lastly, it promises very largely to solve the difficulty which occurs in the frequent drop in quality between the process-engraver's proofs and the printed result which so often occurs in ordinary three-colour process work, because at present it is not possible to isolate the engraving from the printing. In photogravure, these must be done together in one establishment, so that there is co-operation between the two main parts of the work; very helpful to success and so often lacking in the older process.

The ink used in photogravure printing dries very rapidly indeed, and the individual colours can be dried by means of heat and air almost instantaneously. This suggests the possibility of printing the second and subsequent colours with a rapidity hitherto unattainable, and for these reasons I believe that the future of colour printing will be very greatly influenced by colour photogravure, printed on multicolour machinery.

A close inspection of the colour gravure specimens here will shew there is reason for one to expect an important development of colour printing by this method.

You will, I feel sure, be interested in seeing a book jacket, which I believe to be the first printed in colour photogravure, certainly in this country and probably in any other country. Curiously enough it is associated with a famous book and one which was among the greatest of the successes achieved by the firm with which our Chairman is associated.

I have no doubt that our Chairman is under the impression that amongst the more important reasons why " If Winter Comes " achieved such an enormous success was the very clever writing of the author, backed up by the wonderful publishing facilities possessed by Messrs. Hodder and Stoughton, Ltd.

May I venture to suggest an entirely different reason. The book jackets on the first four editions of this wonderful book were printed in colour photogravure and it was only after the prestige and the wonderful circulation of the book was established that the ordinary four-colour process jackets were resorted to. Of course, there may be differences of opinion as to what effect this had on the circulation, but the fact remains that this is the only book which has ever been issued in this country with a coloured photogravure jacket and the success of the book was extraordinary. There I must leave it.

Among interesting items shewn in Exhibit No 12 is a fur catalogue produced for Messrs. Bradley and Co. This is printed throughout in photogravure, the cover being printed in colour and the inside monotone, and I think this is the first time a book of this kind has been printed throughout in this country, cover and inside complete, in colour and monotone in photogravure.

Then, too, I have here a most interesting result of a cloth pad reproduced by this method, the result of which shews great possibilities for advertising purposes, and lastly some reproductions of water-colour sea pictures and hunting scenes.

The *Illustrated London News*, *Sketch*, the *Graphic* and also *Pears' Annual*, have all been active as pioneers in this work, and I am proud of the fact that the firm I have the honour to be associated with is taking a leading part in this latest and I believe most important development of colour printing.

DISCUSSION.

Dr. Arthur Haydon said he had visited the ruins of Pompeii some years ago, and had been struck with the wonderful frescoes there ; they were so fresh as to appear only to have been done yesterday. They were chiefly in the primary colours, and were perfectly beautiful in their formation and in the combination of the colours. He thought the ancients went in more for the combination of primary colours than secondary colours. He would like to know what Mr. Greenhill thought of those frescoes.

Mr. R. A. Peddie said it seemed to him that Mr. Greenhill had been a little unfair to the Orloff process. He had evidently forgotten that magnificent series of Legends of the Neva which had been produced in the Russian State Paper Office by the Orloff process. He could say nothing of the commercial side of their production, but the artistic effect of them was very wonderful indeed.

With regard to colour photogravure, he would like to hear how much of it was produced on rotary machines. The subject of colour photogravure was very interesting to him, because many years ago he had lectured before the Royal Society of Arts on the early history of colour printing, and he had concluded by saying that those interested must look to rotary photogravure for the future of colour printing. In those days there had been very little rotary photogravure, and he thought Mr. Greenhill had proved him to be not an absolutely unsuccessful prophet.

Mr. C. T. Courtney Lewis said one point had always struck him in connection with the subject under discussion, namely, the difficulties which must have faced many colour printers during the war. He called to mind a certain gentleman who, before the war, wrote a well-known book which on publication contained plates so beautiful that after the war the publishers desired to reproduce them. They went to the printers with whom the plates had been left and were told the Government during the war had commandeered them and turned them into bullets. The owner of those plates was himself, the loser of them was the lecturer. The difficulty was, however, got over in a manner so honourable to the gentleman who paid, and so satisfactory to him who received, that he was glad of the opportunity to say so that evening in public.

Mr. Greenhill had referred in his lecture to " A Chronicle of England." Only last week the original manuscript of that book had been sold at Sotheby's, and he had had the opportunity of inspecting it. It had a peculiar history. It was written by Doyle in 1842. It had been shown to Longman's some years after, and they came to the conclusion that they would like to reproduce it. They showed it to the Prince Consort, who was very pleased with it, but it was found that the expense would be so great that the work could not be undertaken. Some years later there had been alterations in the method of colour printing, and Longman's then decided to publish. As he had said, he had inspected the original book and the manuscript, and more beautiful caligraphy from beginning to end he had never seen. He believed it was wholly in Doyle's handwriting. All the pictures were in water colours. He had noticed that there were 85 in the printed book and 135 in the manuscript book, so that there was a considerable difference in the number reproduced. As a matter of fact Doyle had re-written the whole of the book when it was republished and, he believed, added some illustrations later on.

It had been his privilege latterly to look into the history of colour printing as it was 75 years ago, at the time of the great Exhibition ; the prevalent methods then were two—the block process and the Baxter process. The road which had been travelled from those days in mechanism struck one as very extraordinary, and one wondered to what pitch of perfection mechanical processes would be brought in the not far distant future, when, no doubt, the Daily Press would be illustrated in colour. It would be interesting to see.

Mr. R. H. Sawyer remarked that Mr. Greenhill had paid due credit to the printer for collaborating with the engraver in getting perfect results with the various processes described, but there was one point where he rather did what

he, the speaker, thought an injustice to the printer, and that was where he deplored the difference between the block-maker's proof and the actual commercial product. Might he ask whether that difference was not due, firstly, to the fact that the block-maker's proof was produced under exceptional conditions, and, secondly, whether the difference in result was not due very often to the fact that the stock was very different ? Mr. Greenhill would appreciate what he meant. He believed that block-makers had a knack of proofing blocks up on good chromo paper. He would leave it at that.

Mr. T. Leman Hare said Mr. Greenhill had referred to the development which had taken place in colour printing during the last three years, but it had struck him personally that a halt had been called in that development recently, because, leaving out the photogravure process, he could not see that during the last 20 years anything very much had been done. There had been no great invention or improvement. He was inclined to think that something might be done by a further co-operation between the paper-makers, machine-makers or designers, and the engravers and printers. Just as the newspapers had solved an enormous technical difficulty some years ago when they had introduced for the first time half-tone blocks, in like manner something ought to be done in higher-class printing by experimenting with different papers. Whenever one asked printers to do anything they always said it was impossible. That had been the case in connection with the half-tone blocks in newspaper work. His point was that there were innumerable things to be discovered and brought into use which the ordinary printers to-day said were not possible. If half-tone blocks could be printed respectably, as they were in "The Times" and in newspapers which used an inferior paper, how was it that one could not get colour work printed on anything else but the abominable so-called art-paper ? He thought it could be done if experiments were carried out with the idea of finding what the difficulty really was. Everyone knew that it could be done on a pure rag paper, which, of course, was very expensive, but it ought to be done, he maintained, on a paper which was within the reach of business people.

More than 20 years ago in Paris a daily paper had been started in colours, and a very capable production it had been. It had been done on a rotary machine, and he had been present when the first copies had been run off. It was a most wonderful paper of its kind. It was very well printed from colour blocks, which were done by a machine invented by M. Paul Godchaux, and it had always been a mystery to him why that machine or a similar method had not been adopted here. He did not believe the rotary machine had ever been tested to the height of its powers. He maintained that really good colour work could be properly done for the Daily Press if properly organised, and that it would be done. He was not deprecating photogravure in colour as a possible development; it was of immense interest, and he would like Mr. Greenhill to say what he thought, not only as to the possibility of rotary work, but as to the method of combining type with the beautiful illustrations which were exhibited that evening. If work like that could be applied for rapid printing for daily newspapers it would mean an enormous advance.

Mr. R. B. Fishenden said the audience should be grateful for Mr. Greenhill's suggestion for a closer co-operation between the photo engraver and the printer and the publisher, but, personally, he would suggest that an appeal should be made as well for closer co-operation between the artist and the publisher on the one

hand and the photo engraver and the printer on the other. Too often, even when drawings were made specially for book illustration, unnecessary difficulties were put in the way of satisfactory reproduction, which would be avoided if the artist understood the limitations and the technicalities of the method of reproduction and the method of printing which were to be followed.

Mr. Greenhill's references to the matter of permanence were of the greatest importance. His remarks in connection with line illustration and colour line illustration would suggest that they were not, perhaps, using illustrations of that kind so fully as they might, and that, in seeking for the full three or four colour reproductions of straightforward paintings or watercoloured drawings, they were not, perhaps, getting quite the variety in their book illustrations which might be secured if they were to adopt something in the nature of the old colour woodcuts as the originals from which illustrations might be prepared by one of the line processes to which Mr. Greenhill had referred.

The subject of the permanence of inks suggested a question to him: Did Mr. Greenhill consider it practical to modify the straightforward three-colour practice of using normal filters and normal inks, thereby doing away with the disabilities of the fugitiveness of the colour lakes which were used in the preparation of those inks? He would like to ask whether, by the use of a fourth printing and a slight modification of the inks to secure greater permanency, they would not be travelling along right lines?

The references to colour photogravure were among the most important which Mr. Greenhill had made that night, particularly the references to the permanence of the colour gravure, which the Sun Engraving Company were now turning out. Every colour photogravure had not shown that permanence, and the Sun Company were heartily to be congratulated on the progress they had made in that direction. It struck one on looking at the exhibits on the wall that there was undoubtedly a much greater richness and purity of colour than was obtained by the other methods. He would like to ask whether Mr. Greenhill thought that was in some way due to the difference in the technique of the reproduction. In half-tone three-colour printing the tones were represented by dots of equal strength but of varying size, while in photogravure the translation of the tone values was by means of films of ink of different thicknesses, which were only broken up by the grain or screen lines.

Mr. G. A. Rutherford said he had noticed in connection with the pictures displayed on the walls that there was a heaviness about the coloured photogravure in comparison with the three and four-colour process. (Mr. Rutherford here illustrated his argument by referring to several of the exhibits). He did not see anything in the photogravure process which supplanted the three or four-colour process, and he would have to be very much convinced that the photogravure process could be brought to do the beautiful work which was obtained from the three and four-colour process.

Mr. Greenhill, in reply, said Dr. Haydon had mentioned the permanence of colour on ancient monuments, and had referred particularly to the fact that the ancients used primary colours more than secondary colours. There was no doubt at all as to the facts. It was well known that on many of the ancient monuments the reds, in particular, were never surpassed to-day. It was also known that we had lost the art of the ancients in mixing those very permanent colours; but he sometimes wondered whether, although those colours to-day were still very beautiful,

they were at the present time quite the same colours as they had been all those centuries ago. Nobody could tell that, and, personally, he could not say very much on the subject as he did not profess to be versed in it, but it was the fact that the ancients had colours which, certainly, in their effect, could not be matched to-day.

Mr. Peddie had mentioned the Orloff process. He was very sorry if he had conveyed the idea that he did not appreciate some of the good work which had been done by the Orloff process. He had no intention of conveying that idea at all. He was under the impression that what he had said conveyed the idea that he really did admire the ingenious method and extraordinarily clever way in which it was carried out, but he had gone on to imply that it did not stand the test of every-day work and competition. It had, of course, to be recognised that that method had very grave limitations by the very nature of the work. On the other hand, it must be admitted very frankly that there were skilful craftsmen who, by careful design, could, and did, get very beautiful results, in spite of very considerable limitations, by the method adopted.

The question had been put as to whether colour gravure was done on rotary machines. It was done mostly to-day on sheet feed rotary machines.

He thanked Mr. Courtney Lewis for the kindly and friendly way in which he had referred to what had been for a long time a very difficult matter with photo-gravures. During the war copper had been so short and so difficult to get that an arrangement had been made with the Government authorities that a man could get no copper at all unless he first surrendered old copper; and he was afraid that very heavy pressure had made them do some things which would not have to be done to-day.

Mr. Sawyer had referred to what he suggested was rather an injustice to printers in connection with the grave difference between blocks and printing. He had pointed out in his paper that one of the most important factors for reducing the drop between the printed results and the block-maker's proof was that the block-maker should proof the four blocks in one row together so as to get uniform inking. He did not want to convey the idea that either side was the culprit; what he wanted to suggest was closer co-operation. What so often happened was that blocks were ordered from one source; nobody knew how or, in many cases, for what purposes they were going to be printed. No one knew whether they were to be printed separately or in sheets, on very fine, or on comparatively coarse paper. One point he wanted to make very strongly was the following. Many printers had the idea that the block-maker had some extraordinarily weird way of proofing blocks which it was quite impossible for the printer to follow. That was altogether wrong. The process blocks to-day were proofed on printing machines under printing conditions. Anything in the way of faking was rightly eliminated. The block-maker, as a rule, spent a great deal less time in making ready his proof than did the printer. In most cases the printer overdid the work on the blocks, and did a great deal more work in making ready than there was any need for him to do. He wanted to stress the point that it was not nearly so difficult to follow the block-maker's proof as many printers thought it was.

Mr. Leman Hare had stressed the point that there was not very much improvement in the work of to-day over that of 20 years ago. He was willing to admit that, if one took the best work of 20 years ago—the work which had been done by a few individuals who were very fine craftsmen—that was true; but in his opinion the mass of the colour work done to-day was far better than the bulk of the work which had been done 20 years ago. There had been a steady and consistent improvement, both with the process engraver and with the printer, so far as the mass of the work was concerned.

There was not the least doubt that there was room for combination between the printer, engraver, and papermaker. That was exactly what had happened in colour photogravure. Colour photogravure was really a natural development of the three and four-colour process. Machines were being evolved to produce the pressure necessary, and the paper used was altogether more suitable for an artistic and permanent result, so that he thought the combination which Mr. Hare very rightly suggested as desirable was actually taking place, although very slowly—but in the form of photogravure rather than in the letter-press form.

With regard to the development of colour work on paper other than art paper, he was entirely with Mr. Hare on that point. He believed a good deal could be done in the direction of the development of the three and four-colour process on papers other than art paper; but so far all the attempts in that direction had been made on work of the very highest class.

With regard to colour photogravure and type with it, and the possibility of using colour photogravure for fast work, he thought that would follow in time. How long it would take was very difficult to say.

Mr. Fishenden had mentioned the possibility of further co-operation between the engraver and the printer. Personally he had rather hoped that he had suggested one form of co-operation. The idea he had in mind was that when the engraving was being done, the printer, or the client who ordered the engraving, should always advise the engraver of exactly what was going to happen to the blocks—whether it was going to be done in sheet form or singly; whether a large quantity was to be printed; whether it was to be on smooth or rough paper, and so on. There were a number of details like that where advice to the engraver in the first instance would save a great deal of time and trouble. He held the view that the block always ought to be proofed on the paper on which it was to be printed, and that the printer ought always either to follow the process engraver with regard to the ink he used, or he ought to supply the engraver with the ink which was to be employed. Certainly there was room for more co-operation between the process engraver and the printer. If they would only unite on the few points mentioned a great deal of the present difficulty would be eliminated.

He agreed with the point which Mr. Fishenden had raised about line illustration. He did not think sufficient use was made of that process now for illustrating purposes.

The suggestion had also been made that the filters should be modified in order to use colours which were more permanent. As a matter of fact this had been done by all progressive photo-engravers for many years. The adjustment of filters had taken place some years ago, and the colours which were most consistent with permanence were now used.

He thought there was no difficulty in getting richness and purity of colour in colour photogravure. There was no doubt that the beautifully smooth result which the photogravure process gave was due to the fact that there was no dot, as there was in the half-tone, with white paper grinning at one between the dots. One obtained a film of ink which was much more evenly laid over the surface. In photogravure the variation in tone was obtained by variation in thickness of the film and not by variation in the size of the dot; and for that reason one was able to get extraordinary depth of colour, because in the darker tones the cells which took up the ink and yielded the impression were proportionately deeper.

Mr. Rutherford had made some rather severe criticisms, and had taken exception to certain phases of the work exhibited. He (Mr. Greenhill) had exhibited the

examples because they illustrated the possibilities of photogravure. He did not think skies like those on the gravures exhibited could be obtained by the ordinary three-colour process, even on art paper, let alone on rough paper such as that on which the examples shown were printed; it should also be remembered that colour photogravure was in its infancy, whereas the other process was 30 years old. The specimens of three and four-colour work were the result of 20 or 30 years' hard work by innumerable people, whereas colour photogravure was the result of work of a very few years by a very few people. For that reason he thought he was justified in setting forth what he really believed to be the fact, namely, that photogravure would play a very important part in colour reproduction generally, and would in time become a very important asset in the printing of colour work.

A hearty vote of thanks to Mr. Greenhill for his paper concluded the meeting.

THE FORD SYSTEM OF LUMBER MANUFACTURE.

The following account of the system of lumber manufacture adopted by the Ford Motor Company is taken from *The Timberman*, of Oregon, U.S.A. It is claimed that under this system from 35 to 50 per cent. of fine hardwood suitable for automobile body parts is saved, by sawing them direct from unedged planks as they come from the log.

The Ford system is absurdly simple. Planks, with the bark left on, are cut from a log in parallel planes varying according to the shape of the log. These are sent to "layout tables," where patterns for various parts are marked out until the plank is completely covered with patterns right up to the bark. Any irregularities, such as the swell at the butt, are taken advantage of in laying out curved or irregular parts. Instead of trimming off a large piece to avoid a knot or check, the layout men simply go around it. This method permits the utilisation of nearly all the wood, the scrap being extremely small. The various parts are then cut out with a high-speed bandsaw.

Under conventional methods the proportion of board-feet in body parts by actual measurement to the wood-content of the entire tree is distressingly low. One-third of the tree (the limbs and top) is wasted before the log gets to the mill. Only 55 to 60 per cent. of the log is actually converted into body parts.

A sample tree was cut up into body parts under the new method, and the results compared with the amount of parts which the old method of edging and sawing would have given. The results were so startling that the system was put into effect at the various Ford plants as soon as possible. The tree gave two irregularly shaped logs which scaled 238 board-feet. There were also a number of branches and the top. The best use that could be found for these under conventional lumbering methods would be to send them through the wood-distillation plant. Instead, they were sawn up and marked for parts sawing.

After the logs had been sawn by the Ford method and the patterns laid out, the planks were measured up according to the boards which could be obtained under the old edging and trimming method, and the number of available parts in each computed. All parts were reduced to board feet in actual lumber-content. The edging and trimming method gave 127 board-feet of body parts. Under the Ford system the same planks yielded 204 feet, a gain of 77 board feet, or 32 per cent. The limbs and top, hitherto considered worthless except for distillation or fuel, gave 170 board feet additional, making a total of 368 board-feet of parts, as against the 127 board-feet obtainable under the old method.

From now on all hardwood limbs and tops not under four inches in diameter will be brought to the Ford mills. Another saving possible under the new system is in the logging operations. Much timber has been sacrificed in an effort to get straight logs of standard length. Trees have been cut off at a height of from two to three feet in order to avoid the swell at the butt. They now may be sawn six inches from the ground. It is no longer necessary to avoid the crotch of a tree. The shape of the planks is of no consequence.

The body parts produced under the method are superior to those sawn out of edged and trimmed boards, as the grain may be followed more advantageously. This is especially true of curved parts, a large number of which are found in body construction. Much of the youngest and best wood in the tree was wasted under the edging method, but this is now completely salvaged. Not only are more parts obtainable from a tree, but better parts as well.

This practice of cutting the parts to rough shape while the wood is still green has also simplified the whole process of kiln-drying, reducing the spoilage to a noticeable degree, and shortening the time required by approximately 10 days. The old-time lumbermen and wood-workers, who freely predicted that the new system would break down at the kilns, were rather chagrined to find that the parts came through with less warping and endchecking than the boards from which parts were formerly sawn.

It has been estimated that this new system will make the Ford forests last one-third longer, possibly indefinitely, if proper methods of reforestation are followed. A young and vigorous growth of timber is constantly coming up, and these trees will not have to reach full maturity before they become available for body parts manufacture.

In the interests of forest conservation the Ford Motor Co., makes public the new method, and it is hoped that other companies will take advantage of the economies offered. It would be a conservational measure of national importance, if sawmill operators, instead of sawing boards, would saw complete parts or dimensional stock. Automobile body companies, furniture factories, and other woodworking industries could have their parts made right at the mill, thus making an enormous saving in lumber, in addition to which they would profit by lower freight rates. The general scheme of the system is universal in its application.

To the Ford Motor Co. it has been found unusually profitable because the company controls every step in the manufacture of body parts from the standing timber to the assembly line. Here are four industries usually separate and distinct: (1) logging, (2) sawmills, (3) dry kilns, and (4) body shop, to which may be added (5) the wood distillation plant at Iron Mountain, Michigan. They are all united under one management with but one end in view.

As the company's timber requirements have already reached one million board-feet a day, the possible savings under this new system may be estimated at several hundred thousand feet daily.

But, more important still, it appears to have ensured a permanent supply of wooden body parts at a time when the disappearing hardwood forests were a matter of public concern.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

TUESDAY, DECEMBER 29..Colonial Institute, at Hotel Victoria, Northumberland Avenue, W.C. 3 p.m. Mr. F. R. D. Onslow, "Some Sea Birds."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir William Bragg, "The Trade of the Sailor"

THURSDAY, DECEMBER 31..Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir William Bragg, "The Trade of the Smith"

SATURDAY, JANUARY 2..Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir William Bragg, "The Trade of the Weaver."

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FRIDAY, JANUARY 1st, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

TUESDAY, JANUARY 5th, at 4.30 p.m. (Dominions and Colonies Section). M. HENRY D. DAVRAY, C.B.E., Chevalier de la Légion d' Honneur, late correspondent of the *Daily Telegraph* in North Africa, "France in North Africa." The paper will be in *English*. The RT. HON. SIR FREDERICK LUGARD, G.C.M.G., C.B., D.S.O., Commandeur de la Légion d' Honneur, late Governor-General of Nigeria, will preside.

WEDNESDAY, JANUARY 6th, at 3 p.m. (Dr. Mann Juvenile Lecture.) The first Act of a presentation of *Alice in Wonderland at the Breakfast Table*, by PROFESSOR HENRY E. ARMSTRONG, F.R.S., aided and abetted by Alice, Mac Hatter, the Dormouse, the March Hare, Brer Rabbit, the Cook, the Duchess, Father Christmas, and Tar Baby.

The special tickets required for this presentation (the second Act of which will be given on Wednesday, January 13th, at 3 p.m.), have now all been issued.

OPEN COMPETITION OF INDUSTRIAL DESIGNS.

The third annual Open Competition of Industrial Designs will be held in June next, and full particulars can now be obtained on application to the Secretary of the Royal Society of Arts.

Competitions will be held in the following sections:—Architectural Decoration, Textiles, Furniture, Book Production, Pottery and Glass, and Miscellaneous. In addition to a large number of money prizes, a Travelling Scholarship is offered in the Textile Section.

It is intended to confer the Society's Diploma on any candidate whose work reaches a very high standard of artistic ability and also shows practical knowledge of the materials and processes of his trade.

After the work has been judged a number of selected designs will be exhibited in London, and subsequently at suitable centres in the provinces. In this way they will be brought immediately to the notice of those manufacturers who are likely to be specially interested in them.

The Council hope to place the Scheme on a permanent basis and to offer annually travelling scholarships and prizes. In order to secure this object a very substantial capital sum will be required. They therefore appeal to all those who not only are interested in the artistic industries of the country but are concerned for the general improvement of British trade, to assist them in promoting the Scheme. Contributions to the Fund should be addressed to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

Wednesday, December 2nd, 1925.

Colonel Sir Thomas A. Polson, K.B.E., C.M.G., in the Chair.

The paper read was :—

THE FUTURE OF THE MOTOR CAR.

By Lieut.-Colonel Sir Alan H. Burgoyne, M.P.

Companion Inst.Mech.E., M.Inst.P.T., Assoc. Inst. A.E.

In no branch of engineering has more progress been made than in the development of the internal combustion engine. In my paper to-night I shall deal with that development only in as far as it affects road-transport, and it is not my intention, except quite superficially, to deal with the subject from the technical standpoint.

A brief quarter of a century has witnessed a revolution on the roads—twenty-five years ago the motor-car was an eccentricity; just before the war it had become an established fact, but was still a luxury; to-day, it is a necessity, and in the near future no artisan's cottage will be built without its garage as part and parcel of the design.

Just a few hard facts to emphasize this contention. It is useless to go back before the war, but taking the production as estimated by licence certificates issued in the last five years, we find that in this country the figures have been as follows :—

		Private Cars.	Motor Cycles.	Trade and other Vehicles.	Total.	Taxation Yields.
1921	...	250,000	355,000	132,500	837,500	£9,627,205
1922	..	293,740	352,340	152,185	898,265	£10,921,284

1923	...	382,538	391,087	184,614	1,058,229	£12,664,309
1924	...	474,261	440,770	320,500	1,235,533	£14,689,787
1925	...	579,901	571,552	371,748	1,523,201	£15,500,000 (circa)

The figures for 1925 are nine months return only—it is obviously impossible to give the full year.

Now the annual increases here shown do not, unfortunately, reflect the progress of the British motor industry. This industry, at the cessation of hostilities in 1918, found itself in a state of greater disorganisation than the similar industry of any other combatant. The works of the leading makers had almost entirely been taken over for conversion to warlike uses, and when to that was added the moulders' strike, the most disastrous, if little heard of, industrial trouble in recent years, the lee-way our motor-car manufacturers were called upon to make up would have disheartened any but the most courageous. Not unnaturally the producers in America and on the Continent of Europe took, and reaped, full advantage from our misfortunes, and thanks to mass-production on scientific lines in the one case, and favourable exchanges in the other, had obtained an ascendency here and in the Empire generally with their makes that only now shows signs of being successfully combatted. Thus, in the middle of 1924, over 70 per cent. of the private cars in this country were foreign ; in the United States over 95 per cent. were of American manufacture. In France over 80 per cent., in Italy over 85 per cent. were and are still of French and Italian manufacture respectively. With a wisdom our own people have not been too ready to emulate, every country but our own imposed heavy taxes on imported cars, thus effectively stimulating home manufacture and absorption, and restricting the exploitation of their markets by competitive outside opponents. The extent to which this policy has militated against British Industry can be clearly shown. In the first ten months of 1924, France imported 11,042 cars ; of these, only 24 came from Great Brtiain. The total number of cars exported from France in the same period was 34,684 and of these no less than 6,205 came to this country ! In the first six months of this year, of 5,044 cars imported into Germany, only 38 were British, to 675 from Italy, 474 from France and 238 from Belgium. Why ? A duty was imposed for a certain period and then, following a change of Government, repealed ; the average value of cars imported from abroad per month during the seven months preceding the withdrawal of the duties was £627,833, and after their withdrawal, £747,097. The moral is obvious.

Yet to those who have no knowledge of the world's motor position, the increases in cars on the road in this country appear prodigious. Let us get the figures into their true perspective. On December 31st, 1924, the number of cars and trucks in use in the U.S.A. totalled 17,740,236, an increase of 2,427,578 in twelve months. Our own increase, including cycles, over

1923 (of which total some 55 per cent. were imported) was 177,504, so America's increase in 1924 was 2,250,074 more than our increase! The approximate figures of cars (not cycles) to heads of populations are to-day as follows :—

U.S.A.	1 to 6½	United Kingdom ...	1 to 47
Hawaii	1 to 8	France...	1 to 62
Canada	1 to 14	Germany	1 to 250
New Zealand ...	1 to 20	Italy	1 to 375

This year, according to the General Manager of the National Automobile Chamber of Commerce, the production of automobiles in the United States will exceed 4,000,000 as against 3,650,000 last year. Of this last total 3,280,000 were cars, and just over 380,000 of them were exported, mainly to British markets, or, put another way, America exported nearly four times as many motors as were produced by all our factories combined!

If it be thought that the limit of absorption in America is nearly reached I would quote one of the heads of the automobile world, Sir William Letts, who, on his return recently from a visit to the States, affirmed quite definitely firstly, that the wave of prosperity there shows no signs of abating and, secondly, that the idea that saturation point has been attained, or even approached, must be dismissed.

Even in Germany the industry is advancing by leaps and bounds. There are to-day 226 factories producing cars, cycles, bodies and accessories employing over 300,000 men; the production of cars in 1924 increased 180 per cent. over that of 1923. In Italy similar progress is to be noted; in 1914 she exported 1,217 cars, in 1923 this number had become 12,773 and in 1924 over 18,000. The Fiat factory alone employs over 20,000 men. In the motor industry in the U.S.A. at the end of the last financial year 3,105,000 persons were employed on full time.

The value of British-made cars, cycles, cabs, commercial vehicles, etc., exported over the past three years, gives the following figures :—

1922	£2,765,500
1923	£3,899,000
1924	£6,513,600

This year the exports for ten months show an increase of £2,534,450 over a similar period last year. This is good and shows that, against great odds, our manufacturers are making certain strides. It must be borne in mind still, however, that in 1924 no less than a dozen factories in America produced individually more than all our firms put together! Then, too, our total of motor-cycles is huge, half the entire registration of private vehicles. The boast is made that in their manufacture we lead the world. This is quite true, for we are practically the only nation that, relatively speaking, uses them. In the United States a car is as cheap as a British cycle-combination. Abroad they are rarely seen—I recently toured 2,400 miles

through France, Italy and Switzerland and we saw only five motor-cycles and but seven British cars!

From all this it would appear that, healthy as is this industry to-day, it is capable of much greater and more rapid expansion. Thanks to the ridiculous method of Government taxation, our designers have been forced to develop the small-bore, long-stroke, high speed light-car engine, and in this sphere we undoubtedly lead the world. But with all their virtues (and I criticise them not at all) they do not and cannot stand up to the rough-and-tumble work in our Dominions and Colonies, and this fact, coupled with their high relative cost, leaves the large, square-engined American car in almost undisputed possession of markets that should be ours. For overseas I say quite definitely, having wide experience of and many interests in our Dominions, British cars must be developed upon American lines and sold at competitive American prices. It is useless to quote better workmanship, superior appearance, finer material, more up-to-date design; these are all excuses for our innate conservatism. Nor is it helpful to condemn the American production on this or that score—it sells and goes on selling; it is very cheap and it does its job; if it did not, its markets would soon close, instead of which they expand. Where luxury is concerned we lead the world, the Rolls Royce, Sunbeam straight-eight, Lanchester or Daimler are without compeers; but they are for the few and not the masses. The vast overseas market of the future lies in the large, high-powered, cheap, mass-production car, and I believe we have the grit, knowledge and capacity for filling this ever-growing demand.

As a motorist of over twenty-five years' experience (I often have new models submitted to me for criticism from the owner-driver's standpoint), I say this to the designer and manufacturer: "Give the motorist what he asks for, not what you think he ought to like!"

Many foreign cars are fitted with attractive and quite unnecessary accessories that are a determining factor in their sale. The cost of these fitments is infinitesimal, as a rule; if, therefore, their addition will sell a further 250 cars, put them on rather than tell prospective purchasers they are futile and not needed.

In offering these comments let me say that I know well the difficulties under which our manufacturers have to labour. An output of hundreds of thousands per annum is the first consideration for the mass-production on a paying basis of a 20 h.p. six-cylinder car at, say, £400 all on. The corporation undertaking such a task would have indeed to be very wealthy, very brave and very far-seeing. Moreover, all the leading motor firms are to-day doing well, many indeed are progressively extending their factories to meet increasing demands, and they cannot be blamed if, having a certain and profitable future in prospect, they should hesitate before setting out upon a course the outcome of which must remain problematical.

Then, too, cheap as American cars are, it would not strain either the manufacturers, importers or agents to reduce them to a far lower sum if serious competition threatened their markets. With expanding business our makers of light cars will lessen their prices still further, and I personally know of two firms with designs ready for a small 4-cylinder car to sell in the region of £100. Here we get a feature of human psychology that deserves mention; the motorist who starts with a 10 h.p. light car rapidly loses his content with its performance, however good. His second car, if his exchequer warrants it (and he or she gladly pledges the future for a car in a way that is unthinkable for any other commodity!) will be a 12 h.p. or, maybe, a 13.9 h.p. But to quote a French proverb, "appetite grows with eating," and in two years he is looking with interest, envy and desire at the large sports-tourer of 15.9 h.p. upwards, preferably with a six-cylinder engine. At once the price leaps up, and only an innate patriotism frequently prevents our motorist, now entirely in the toils of his hobby, from falling for a vehicle of foreign construction.

This mental process is well known to certain wideawake manufacturers, who are producing a series of light six-cylinder vehicles at all-on prices of £375 to £650.

The nominal horse-powers are such as to bring all within the £16 annual tax, the chassis sufficiently large to permit a comfortable four-seater body either of closed or open type. It will be noted that I emphasize the six-cylinder car; I have neither the space nor the time here to argue the case for this or that number of cylinders; suffice it to say that the good six-cylinder engine possesses certain incontestable advantages over the good four-cylinder, a fact that its growing popularity with the motoring public clearly proves. The eight-in-line will have an increasing vogue, but here (as formeriy with the six as against the four, and the four as against the two) price has been and will remain a dominating factor. Yet if a light six-cylinder car of 16 h.p., R.A.C. rating can be produced at a price comparing favourably with a four-cylinder of, say, 20 h.p., of the two the nominally lighter-powered car will, without question, command the larger sale.

Now let us consider the probable future lines of development of the motor-car. Despite the enthusiastic captions of paragraphists in automobile advertisements, we are nowhere near finality in design, type, or price. Because this is so I hope no futile legislation will be introduced seemingly suitable to the needs of to-day, but the value of which natural development will in a few years entirely negative, and to which development it might prove harmful.

Dealing first with the engine, the following indicate a few obvious tendencies:—

(1) A super-charger: of British initiation, this mechanism for "boosting up" the power of an engine is being developed abroad and ignored here.

(2) An oil-filter will be standardised, as also will

(3) An air-cleanser for the induction.

(4) The poppet-valve will more and more be superseded by some design of sleeve valve; many such, entirely reliable, are on the market to-day. There are other types of vibrationless engines now in the experimental stage, which in turn may supersede the sleeve-valve.

(5) The magneto will disappear.

(6) Belts, whether rubber or leather, are obsolete; everything in future, requiring impulse, will be positively driven.

(7) Carburettors will be developed to permit a direct flow of gas through the induction without the intervention, and consequent complications, of jets. The ideal will be attained when engines are supplied with definitely regulated quantities of propulsive spirit-gas and air by forced injection, so that the ratio between the two will remain constant regardless of piston speed.

(8) The fan, if not dispensed with altogether, will be fitted with a clutch for disengagement in cold weather, or at signs of too low temperature on the engine or radiator temperature-gauge.

(9) Petrol-tank fillers will be on the off-side of the car out of the way of luggage racks; an emergency tank and dash-board petrol-gauge will, of course, be standard.

Turning to other probable features of future cars, one grade of oil will be used throughout, for engine, gear-box, axle and general lubrication. A central lubricant tank, with dash-board quantity-gauge, will be filled as required just as is the petrol-tank, and from this all lubrication will automatically take place. In this I include the friction points of the chassis, since oilers of every description will be eliminated; their duties will be carried out through pipes from the central reservoir by automatically regulated pressure.

Bumpers and four-wheel brakes will be made compulsory; a definite standard height for the former, from the ground, should at once be agreed by the manufacturers. As to the latter, the band-brake will be displaced by the multiple-shoe internal expanding brake.

Gear-changing will soon be a matter of history; infinitely variable gear mechanism, automatically actuated, will become a standard fitment.

Other pending developments, not likely in the near future to affect the general trend of design, are the abolition of water-cooling and the front-wheel or four-wheel drive. As regards the former, the main advantage will lie in the saving of weight, as to the latter, in its dual suggestion; the matter is too much in its infancy for detailed discussion. The Alvis firm have produced an admirable and efficient front-wheel-drive sports car of high speed and great reliability. Nor must the wider application of hydraulic power to motor design, now in its infancy as a study, be omitted from mention.

Turning to the chassis, accessibility is in the essence of progress here, that and strength combined with adequate flexibility. To-day the body-builders and chassis designers are in a state of constant warfare, usually quite unwittingly. More and more the demand is for closed bodies, and in America the standard production for many firms is the "coach" or "saloon"; these are their cheapest models, and open touring cars, either two or five seater, are more expensive. But one change must and will take place. The modern chassis is so sprung that its flexibility is phenomenal, and with the torsional and transverse stresses set up and allowed for in chassis design to-day, rigid bodies as built in the past must soon squeak, crack, if not entirely rupture. Many leading builders swing their bodies on rubber buffers and this may prove a temporary solution; the more obvious way is to provide bodies as flexible as the chassis, and here the fabric body on a skeleton frame has met, and is meeting, the growing demand of satisfied users.

Interior heating and cooling, and unsplinterable glass will become standard, non-dazzle lights or dipping-lights will be legally compulsory, and a further compulsory fitting will be a yellow fog-light fixed low down and well forward on the near side for the illumination of the curb or road-edge in thick weather.

On the dash-board, a petrol-gauge, gradient-meter and oil-gauge (for quantity in central reservoir, as well as for pressure in engine if this be needed) will be regarded as essential. Probably, too, every car will have to carry a brass plate with the name and address of its owner.

Now the incorporation of these many suggestions into a vehicle for mass consumption can only be considered in relation to mass production. I have shown how, relative to the States, we are in the early stages of motoring, but there is every reason to suppose that in due course (as trade recovers, unemployment decreases and exchanges stabilise) we in the old world will follow closely upon the heels of the new, where the motor-car is now to the people as necessary as chewing-gum.

To-day, 4,000 new motor registrations are being taken out every week; this is an increase at the rate of 200,000 vehicles (excluding motor-cycles) per annum. Last year the figure was half this number. The increase is actively progressive, for next year the output of British firms will not be less than 200,000 cars, and this is a conservative estimate. The importation will probably be at least 100,000, and it is no idle prophecy that (including cycles and trade vehicles) half a million additional licences will be taken out. There is a potential market in this country alone for between six and seven million motor-vehicles; as these become cheaper, as they will with quantity production, the ratio of motor-cycles to cars will drop, and I doubt if, at the point of highest car consumption in this country, the number of cycles registered will exceed the total of to-day. As cars come

down in price, and the influence of the McKenna duties on foreign imports takes wider effect, the reputation of British design and workmanship will lead to expansion of trade in home products throughout the Dominions, Colonies and Dependencies in most of which preferential advantages are already operating in our favour.

This is no idle prophecy, but its successful fulfilment is vested in two desiderata; first, there must be no restrictive Government interference, either by regulations or taxation, and, secondly, our manufacturers and designers must combine to produce, for the various potential markets, the type of vehicle the consumers with their knowledge of local needs demand.

With the prospect of 14 to 15 motor-cars on our roads where to-day we see but one, a number of problems of premier importance immediately arise. In regard to the towns the effect upon our already congested traffic is likely to be disastrous unless preparation for the startling increase is made fully in advance. I venture to offer one or two suggestions which, carefully surveyed in the right quarters, might lead to helpful endeavour. In large cities, all horse-traffic should be confined to certain streets between, say, the hours of ten in the morning and five in the evening. The actual ratio of cost of motor-transport as against horse-transport, even for short delivery journeys, is rapidly decreasing, and the horse as a commercial proposition will inevitably disappear as it has done in the United States. Slow-moving traffic must hold rigorously to the side of the road both in town and country, and where such traffic is of a mechanical nature, its speed should definitely be regulated by mechanical means incapable of being tampered with by the drivers and subject to periodical inspection by Government officials. Trams are doomed, and whilst for the moment they may be essential as a means of transport at peak hours, the fact that they are financially unprofitable and will tend more and more to become so as motor-buses increase and improve, is in itself sufficient reason for a safe prognostication of their demise. Until, however, this happy period is reached, they provide a factor needing the institution of stern by-laws. It would be as impossible to stem the progress and popularity of motor traffic as it was to prevent the development and construction of railways a century ago. In these circumstances, the slogan upon which all regulations and laws should be based must, of course, be "Safety first"; this in the interests of the community as a whole, not only of motorists, but of those who think they and we are likely to suffer from the advent of the new and inevitable era.

One or two suggestions at once occur:—

(1) No two trams, or tram and bus should be permitted to pull up side by side, entirely blocking all traffic, as is the case in a thousand places throughout London to-day. Nor should they be permitted to block cross-streets as at present.

(2) Motors should not be permitted to pass on the near side of trams that are stationary for the purpose of setting down or picking up passengers.

(3) White lines of intensive depth should be placed behind stopping places of trams, and from behind these lines motors should not be permitted to move until the tram has restarted.

(4) Stationary cars must not be allowed to stand more than 18 inches out from the curb, their front and rear wheels must be left parallel and not with the front wheels turned outwards.

(5) No vehicles should be permitted to turn round against the traffic, nor should they be allowed to draw in to the curb on their off side, since to do so would be driving across traffic coming in the opposite direction.

(6) The laws of obstruction should be stiffened up and rigidly applied: obstruction in traffic means slowing down, slowing down means loss of time in trading and thus loss of prosperity to the country.

(7) The principle of one-way traffic must be applied where it can be proved practicable.

(8) Policemen on point duty should all wear either white armlets or white gloves.

(9) The real cure for traffic congestion, and the even greater congestion that is coming, will lie in the happy co-ordination of all types of traffic, mechanical, electrical and horse, slow and fast.

Turn to the country: the following are a few suggestions which would touch motorists outside the towns:—

(1) The application of white lines round sharp bends must be very carefully considered before applied. At present these are being placed everywhere, with the result that the tendency is to ignore their existence.

(2) Private warning signs must be forbidden. They are a piece of unbearable swank, since it is the duty of the householder, who thus informs the world that he possesses a drive, to exercise the necessary care in coming out on to the road.

(3) Road signs should be reduced to the minimum, and, furthermore, should all follow one certain design both in shape and lettering. Unnecessary signs distract the attention of drivers who, as much as possible, should be concentrating on their work for the safety not only of their passengers, but of anything or anyone that may be upon the road.

The problem of our roads is pregnant with difficulties, and it is well to say here that not only do we possess the finest roads in the world, but that the Road Fund is efficiently and economically administered, costing less than 2¼ per cent. for administration charges. First, then, as to this fund, it would be disastrous if it is to be rifled by the Chancellor of the Exchequer. At the present time the whole of it is allotted to the repair and construction of the roads; doubtless in time this Fund will rise to 70, 80 or even 100 millions of money per annum. Some assurance should be given by the

Government on these points: (*a*) that after a certain figure has been passed the amount of the Road Fund applied to roads will be upon a proportionate basis, and (*b*) any surplus shall be devoted to the relief of motorists in the present heavy cost of taxes on their cars, a cost which is highly damaging to the British export trade. It would certainly be most unfair if the Chancellor of the Exchequer were to regard the motorist as a means of escaping from any deficiencies in a Budget for which they, the motorists, are not responsible.

The construction of new roads is still largely, as far as the surface is concerned, in an experimental stage. That many of them are terribly dangerous can be affirmed by any normal motorist, but that this matter and others of a similar nature will, in due course, be overcome I have not the slightest doubt, for our engineers are, I frankly believe, as capable as any in the world. Of course, all main roads must, as far as possible, be straightened and all blind corners removed. Crossings at main roads should be protected by suitable island obstructions in the side roads tending to slow down crossing traffic, and in every case where a side road enters a main road a large warning notice should be placed, instructing the motorist to stop, and informing him there is a main road crossing. Furthermore, side roads should not cut across main roads at right angles; they should join main roads with a slight sweep in the direction of the main road traffic flow. Councils should be given a design of signboard where the various arms upon which the directions are written do not cover one another and the letters might well be constructed of reflective matter to enable them to show up in the rays of motor lights at night.

The present system of cambering roads from the centre to the edges is an increasing danger. Heavily loaded lorries are forced on such roads to keep to the crown, and I have seen may cases where, when drawing to one side to allow a faster vehicle to pass, their back wheels have skidded down the camber in a most alarming manner. Roads should be bedded as nearly level as is commensurate with proper drainage. Round the corners roads might well be banked, and such banking would do more even than white lines to keep traffic in its proper position. The ideal road is, of course, a concrete surface road, but the expense of this is very high. Meanwhile, with the stringency of money, the various county councils are not in a position, without Government help, to make up efficiently more than a very small percentage of the roads under their ægis at a time, and for the rest are bound, having no alternative, to resort to patching. More control is obviously necessary during the annual tar-spraying season. There are many road coverings to-day on a tar basis which do not splash when vehicles go over them even soon after being laid, and it is monstrous to think that many beautiful new motor cars are irretrievably damaged till the next painting through the application to the roads, by thoughtless surveyors, of a material

which can be replaced by something entirely innocuous and just as efficient.

May I quote here Sir Henry Maybury, Director General of Roads, when he said, "The roads must keep pace with the requirements of the motor industry if that industry is to flourish, and it is to the interests of the country that it should flourish." One terror of the road-maker should be abolished, *i.e.*, traction engines with chain-operated steering. Nothing tends so much to destroy the surface as the dishing progress of steering wheels so controlled. No mechanically driven vehicle should be licensed unless rubber tyred.

Now for a few general observations touching the future of motor cars. We shall doubtless next year have a new Bill presented to Parliament which will endeavour to deal with some of the most pressing problems. Are we or are we not to retain the 20-mile speed limit? The only reason I am against it is because everybody of whatever age or sex who travels any day in either bus or taxi breaks this law, and a law that is broken with the utmost impunity by 999 out of every thousand persons in the land cannot reasonably be brought up against the one or two who are trapped as the result of a passing whim of a local authority. The real test is whether or not the motorist is driving with due regard to the safety of those round him, and no reasonable motorist will object to any penalties threatening those who drive to the danger of the public. It is quite possible to drive with safety at 60 miles an hour and to endanger life going through a market place at 10. The question of driving tests is very complex. I am bound to admit I am more and more, as new, inexpert, and dangerous drivers come upon the road, leaning in favour of such tests. Third-party insurance should be made compulsory, and, indeed, it would be well that the trade should adopt it as one of their own laws that no car should be sold without the addition to its price of the price of the first year's insurance being included at the same time.

Perhaps the most unfortunate result for popularity in motoring lies in the way in which business firms have thought it well to spoil the countryside with unsightly advertisements. Any movement set on foot to have these abolished will be received with acclamation by the public at large.

At Goring Station a garage is being provided by the Great Western Railway for the small cars of those who travel by train and have to come some distance to catch it. This is a move in the right direction, and we shall also see the question of municipal parking places more closely studied. I should like to say here that I am not an opponent of the authorities who will not allow cars to stand in streets or parking places more than a certain time. If this question is not tackled with earnestness and severity now, the state of our streets and parking places, when there are six or seven million cars on the road, will be too dreadful to contemplate. Above all, the law forbidding cars to be left with their engines running must rigidly be enforced, this not only for the noxious gases that will contaminate the air in towns,

but also the loss in petrol, which is a very considerable factor. It is estimated that 400 million gallons of petrol are wasted annually in the United States by idling engines, at a daily cost of £55,000, or over £20,000,000 per annum.

It is reasonable to ask that a tax-rebate should be given upon cars after they have attained a certain age; this not in the interests of their owners, but as a stimulus to the industry. At the present time many an owner of an old car who desires to purchase a new one retains his old one for a longer period, in that he finds it, owing to the heavy tax, entirely unsaleable. Were the tax reduced, after a certain period, in annual amounts, the time would arrive when in many cases these old cars, still excellent and reliable, would be suitable with a box-body for commercial work, for which, owing to their high tax, they have at the present time no attraction.

I believe that in the interests of motorists themselves all makers should enforce a speed limit on new cars for the first 500 or 1,000 miles, sealing the device limiting the speed and, in the event of this seal being broken by any except the factory or an accredited agent, withdrawing from the owner the usual guarantee given for the car.

Two other questions it is necessary to mention before concluding: first, whether the present horse-power tax is the best; the second, are we likely to have any shortage either of rubber or of petrol? As regards the tax, all except four States in the United States of America now have the petrol tax, which obviously, from the practical standpoint, is by a long way the most successful method, since the taxpayer pays for the amount of use he makes of the roads. To say that in this country we cannot devise a means of safeguarding such a tax is, of course, ridiculous. There are others who prefer the suggestion of a weight tax. It is not possible here, nor would it be wise, to dogmatise in this matter, but I know that the mass of the motorists are with me in condemning the horse-power tax as at present imposed. As to petrol and rubber, a very high authority, Sir Richard Redmayne, warns us that within a century we shall be reaching the limit of the earth's output of the former commodity. Other distinguished scientists combat this statement, but whichever view is right, we may have considerable confidence that long ere the real shortage sets in other propulsive spirits will have been developed, which will permit the continued progressive advance of motor traction. Rubber is in an entirely happier category. For the next five or six years we may anticipate, I regret to say, an increasing rise in price, owing to the demand caused by the sudden outburst of popularity in motor-cars having caused a draught upon visible stocks of rubber from the areas already planted. As the result of the recent rubber boom, however, enormous new areas are already in course of development, and from 1931 onwards we shall see an amelioration of the position which, in due course, should lead to a reduction in the price of tyres, at present a heavy factor in the charge of motoring. The modern cord tyre is an article

of such reliability to-day that it is no uncommon thing, even on a heavy car, to find a cover lasting from 14 to 18 thousand miles, and those of us who were pioneers in motoring will remember with pleasure our delight when we made a smooth or studded tyre precariously reach a mileage of 2,500 to 3,000 miles.

This paper has already lasted far too long, and yet the problems that are raised by the discussion of the future of the motor-car are so varied and so many that it would have been difficult to have brought my views within a lesser space. Doubtless, in the course of the discussion which will now follow, we shall have many valuable suggestions advanced which will be of great service to those whose business it is to watch this very remarkable modern development.

DISCUSSION.

MR. E. HOWARD WILKINS suggested that when the regulations for the control of motorists referred to by the author were put into force, it would not be altogether unwise to pass at the same time regulations for the control of pedestrians. A great deal was heard of driving to the danger of the public, but not very much about walking to the danger of the public, although the latter was almost equally dangerous. All motorists had experience of pedestrians who would not keep to the footpath even where one was provided, but who walked, perhaps three abreast, in the middle of the road. Where people did that deliberately because they had a spite against motor cars it should be possible to take some action against them.

The author had suggested that motor manufacturers should include a free insurance in the price of their cars. Personally, as President of the Corporation of Insurance Brokers, he could not approve of that policy, since it would result in the purchaser being tied to one particular company. Most people had their own channel through which they conducted their insurance business, and the person who sold the car should not dictate to them in that regard. He believed in the desirability of compelling all motorists to insure, especially against third party risk, but thought it would best be done by refusing to grant a license to anyone who could not produce a cover by insurance against third party risks for the period for which the license was issued. Only recently his car had been run into by a motor-cyclist who was not insured against third party risks. The Government should compel all motor drivers to take out such an insurance.

MR. LLEWELYN B. ATKINSON (Past-President, Institution of Electrical Engineers) said that the whole history of the internal combustion engine and its development had taken place within the span of his own life. As a boy of 12 or 13 he used sometimes to go to a shop in Oxford Street where there was one of the earliest internal combustion engines, a gas engine invented by Lenoir which worked by exploding gas and throwing a heavy piston into the air, which caught on a rack and came down slowly. He also remembered a little engine called the Bischop engine. There were special instructions with it on no account to let any oil get into the cylinder! It worked with a cast iron cylinder and piston, and he presumed the graphite in the cast iron lubricated it. At any rate, it needed no inside lubrication whatever, although it ran at great heat because of the absence of cooling arrangements.

The next development was the Otto-cycle engine. He remembered later being introduced in Paris to the Comte de Dion, who took such an enormous stride in bringing about the consumption of petrol in gas engines, thus inaugurating the motor car era. As a young man he had also been very friendly with Fred Royce, and had ridden in Royce's first car. It was a very different machine, of course, from that which was so familiar to-day. Royce was one of the cleverest engineers of his day. He was almost a super-man as far as motors were concerned, and he had left his mark on the world as the producer of the internal combustion engine in its highest form.

He was glad the author had referred to the question of taxation of motor cars. The fact that the design of motor cars in this country was entirely regulated in a wrong direction—as he believed—by the method of taxation on an arbitrary or imaginary horse-power, was very serious. It was bad from the point of view of this country, and it was certainly bad, as the author pointed out, from the point of view of the export trade, because the type of engine developed by our present taxation was quite unsuitable for rough countries and rough users. Personally, he possessed two American cars, not because they were cheap—because as a matter of fact they were very expensive so far as taxation was concerned—but because he liked the big slow-running engine, and the avoidance of the necessity constantly to change gear. Last summer he went from Buckinghamshire to Cornwall, 250 miles, and except once during a traffic hold-up in Exeter, he never touched the gear lever. With a car of that kind one did not need to bother about automatic gearings or gear shifting arrangements.

In England such American cars—even the four-cylinder variety—would go anywhere without the necessity to change gear. As he himself lived in a hilly country, where there were narrow roads and frequent sharp turns, a car of that kind appealed to him, and in the West of England it was the type that everyone wanted. They did not want engines which were slow on hills, but preferred the big square engine which the Americans provided, thus avoiding the necessity to be always changing gears.

The motor industry of this country ought to take up the question of taxation and try to get something done. If the basis of taxation were changed it would improve their output enormously. There were very many people who would like to have a second car if it did not cost anything from £20 to £30 a year even to keep it standing idle. He thought it might be possible to increase the sale of cars in this country by as much as 50 per cent. if it were not for the tremendous taxation on cars which were not used much, but which it would be convenient to have for occasional use. A change in the method of taxation would certainly receive the support of the general body of the motoring public, which was a growing body.

The author also referred to idling engines. Some years ago he took the trouble to fit a small Humber 11.9 machine of his with an arrangement by which he could measure the amount of petrol that it used per minute, both when running and standing still, and he had been surprised to find that when the engine stood "idling over" it used very nearly as much petrol per minute as when running from 25 to 30 miles an hour. The reason was that a very rich mixture was necessary to keep it running slowly, and it was really only half burned. Most cars were burning approximately as much petrol a minute when idling over as when running on a fairly level road at high speed.

With regard to the question of magnetos as compared with coils, he was altogether in favour of the coil. It was true that with a self-starter—if it would work—one could start up with a magneto as well as with a coil, but if one had to start a heavy

engine on a cold morning with the starting lever, one would realise the enormous advantage of a coil over a magneto.

Something had been said about roads. The other day the newspapers made a great deal of fuss about an accident to the Prime Minister's car. He knew the corner where that accident occurred, and it had been a death trap for many years. Such corners should most certainly be avoided as they presented a very real and grave danger. Now that the Prime Minister had had personal experience of that, he trusted something would be done. Motorists often grumbled about the police, but recently, when motoring through England, he had with him an Australian gentleman who did a good deal of motoring in his own country, and one of the things that struck him most over here was that the police who were controlling the roads seemed to have their interest concentrated in getting the traffic along. He said that in Australia their chief object seemed to be to find out some way of getting people into trouble for breaking the law.

He agreed with the previous speaker that pedestrians required regulating just as much as motorists. In regard to the white line which was now being used, for example, the difficulty about keeping to the proper side of that line was that there were often lots of people loafing about and talking on the road, and one had to cross the line to avoid them. If motorists were to be compelled to keep to the right side of a white line it should be made clear that pedestrians had no right to block it by loafing about without any real purpose.

The question of driving was very important. It was remarkable how little people realised the attention that should be devoted to driving a car when it was going at anything from 20 to 50 miles an hour. One saw drivers talking and looking about in all directions and doing a thousand other things than keeping an eye on the road in front of them, which was all they ought to do. Personally, he had driven a great many thousands of miles and he had never yet hit anything but one dog, but when he was driving he attended to nothing else. That was the only way to be safe on the road. A locomotive driver who did not pay attention simply to the road ahead and to the signals would very soon get into trouble, and people who drove cars at high speeds on crowded roads, and yet spent their time talking to people and looking at the scenery, ought not to be allowed to be in charge of a car at all. Half of the accidents which occurred were not due to stupidity but to people not attending to their job.

Mr. A. E. Parnacott said he had had a large experience, not only of driving, but also of manufacturing cars, and of experimental work in connection with them. In his opinion the motor car industry had a great future before it and was destined to be second only to agriculture in dimensions. It was through the motor car industry that this country might be able to regain her old industrial supremacy. The territory and population of the British Empire were four times those of the United States of America. The United States was at the present moment top dog as regards the production of motors for the world in general, a position in no small measure due to the efforts she made when shirking her share in the great world-war. Notwithstanding that, British cycles and motor cycles had beaten their American competitors. He hoped the author would use all his great influence towards bringing about a similar consummation in the near future in the case of the motor car and motor lorries.

In that connection a great deal could be effected by a change in the basis of taxation. The £100 car would be a commercial proposition if it were not for the tax. Sales increased enormously as the price was brought down. It was the larger type of British car which felt more keenly the competition from overseas, and only

a radical departure from chassis design could enable British builders to compete with foreign cars. Vastly improved suspension and springing were required to enable the vehicle to ride over the worst roads without the least shock. Six or eight cylinders were essential. British manufacturers were not catering at all at present for the vast bulk of the territory and the population of the empire. The friends of motoring had framed the so-called horse-power rating, which had been adopted by the Treasury for taxation purposes, and thus stunted the growth and development of British cars, making them very unsuitable for the bulk of our great Dominions and Colonies overseas. If, however, protective encouragement were arranged so as to make it worth while for manufacturers to adopt a bold policy, the future of the motor car would bristle with profitable possibilities of usefulness. No one could be expected to take the matter up without protection being afforded to any original ideas he might incorporate in the design of his cars. It was usual for a patent to expire just when it was about to become remunerative. That was manifestly wrong. A man who stole property was punished as a thief, but those who stole inventions, which were the very cause of our civilisation, escaped with impunity. He asked the author to use his influence towards enabling patent protection throughout the Empire to be obtainable by one payment, and to secure patent protection for 50 to 100 years. It was unfair and bad for trade that it should cost as much as £1,000 to patent an invention throughout the Empire. An author or poet could be protected by copyright for a moderate sum throughout his lifetime and into that of his next of kin, and therefore a longer period was clearly desirable for patents.

With regard to taxation, its effect on the distortion of design had been altogether disastrous. The present method of rating took account of only one of the three dimensions of an engine. The industry had suffered enormously through it, although it had been originally brought forward by those who were regarded as the friends of motoring. People overseas wanted a vehicle which was capable of travelling on unmade tracks and which would not pull the roads to pieces. It was not worth while for engineers in this country, however, to construct such vehicles at present for the reasons he had already mentioned.

It might be asked how taxation should be assessed so as to have a healthy effect and lead to the evolution of a vehicle which was suitable for contractors and farmers in this country, and for the general population overseas. He suggested the tax should be imposed on the mass which was below the springs of the vehicle on the main axle. If the tax were imposed on that easily ascertained weight it would mean that people would reduce the unsprung weight, which was the chief destructive element in the weight of the vehicle. The impact of the wheel on the road increased as the weight multiplied by the square of the speed. One could not tax the speed directly, but one could tax the weight, and the weight was easily ascertained. He hoped the author would use his good offices to investigate the merits of that suggestion and forward it. Its adoption would enable us to provide our Colonies with vehicles which would bring their commerce to rail-head or port in a way that was impossible at the present time, and would enable proper vehicles to be constructed for military use.

MR. CHARLES LANDER thought the area covered by the paper was very wide. The author referred to the square engine, the big woolly engine as it was called at one time, which had now been improved. He had hoped that the author would deal with a matter which was of serious concern to the manufacturers of this country. The Vauxhall Motor Car Company had been taken over by that great

American concern, General Motors. That was a most disquieting development on which comment would be valuable.

Personally he did not agree with what the author said about super-chargers. If one imposed on an engine certain stresses the engine had to be strong enough to bear those stresses. It was suggested in the paper also that oil and air filters were necessary. It it was necessary to have them in order to sell the car they ought to be put on, but they were not so necessary in this country as in America and overseas, where the roads were so much more dusty. Poppet valves, he thought, would go, but though the same thing had been said about the magneto, he could not entirely agree with Mr. Atkinson's remarks on that subject. He was glad to hear the author speak of the elimination of the horse and the tramcar. That was a very necessary step. He also was inclined to agree with what had been said about careless pedestrians. In America they were dealt with very severely. In regard to driving tests, he would like to know whether they would have to be paid for, and if they would involve another huge number of Government inspectors he would be against them. He favoured third-party insurance being made compulsory but it should not be included in the manufacturers' charge. It was difficult enough to sell a car at full list price without that! A reduction of taxation on old cars. was very necessary, but he thought it would be better to reimpose the petrol tax That was the only just method of taxation. In America the petrol tax worked satisfactorily, and the Americans were very shrewd in regard to such matters.

THE CHAIRMAN said he was not in the least interested in the future of motor cars in general, but he was intensely interested in the future of the British motor car. He believed there was a tremendous future before the British motor car industry. It was true that, because of the more favoured position in which America found herself during and after the War she had exceeded beyond even her own expectations in getting a very big footing in the Dominions and Colonies, but he was glad to notice that there was a strong wave of patriotism to-day throughout our Dominions and Colonies in favour of the products of the Mother Country. That feeling was so pronounced that he believed, given greater enterprise on the part of British motor manufacturers, and the recognition by them of the principle that they must endeavour to supply what the public demanded, that it would be possible to accomplish much towards the development of our overseas trade. It was in that direction that the Americans had met with a great deal of success. The British Motor manufacturer had more or less set his face against building a chassis with a 4ft. 8in. track and a 10ft. 6in. wheel base and at least 10 in. clearance, which was necessary in order to cultivate a large volume of trade in those of our colonies where the roads were little better than tracks.

He did not entirely agree with the Author that it was the car of 16 h.p. and upwards that was likely to be in greater demand in the future. His own experience led him to think that the car of round about 12 h.p. was the one which was going to sell in the greatest numbers in the future, and with the efficiency and enormous capability of an engine with a bore of 72 and a stroke of 120, for example, that powered engine would be found able to do anything that the average motorist required, and was probably more suitable for British roads than the car of higher horse-power.

He was at the Scottish Show recently, and two prominent motor engineers told him of their experience with a car of the power he had just mentioned. They told him they had driven that car over the very worst roads and up some of the steepest hills in Scotland, and it had amazingly been successful throughout.

So far as the future of the British motor car was concerned, no one outside the

trade could have the slightest conception of the power and the influence of the re-imposition of the McKenna duties on the trade to-day. The price at which cars could be sold was governed entirely by the number which could be sold, and in the case of one company in which he was interested, whereas the average price they obtained for their cars four years ago was £453, the average price they obtain to-day for a car of the same type but of greater value was £223. That was largely due to increased production. If the Government would give British manufacturers the protection to which they were entitled, and would make it impossible for the manufacturers of foreign cars to sell their products in this country at prices comparable to those of cars of home manufacture, not only would the price of British cars come down but it would be a very important factor in the reduction of unemployment. He hoped the Author would do all he could to impress that on the Government, not necessarily by speeches in the House of Commons itself but by badgering the members of the Government on the most inconvenient and every possible occasion.

THE AUTHOR, in reply, said he had been not a little instructed by the discussion. He had not for one moment meant to suggest that the manufacturers should choose the insurer for the purchaser, but when one bought a new car one was presented by the agent with a large form to be filled in, and in that contract of sale one might well have a provision with regard to insurance, leaving it to the purchaser to write in the name of the Company through which he wished the insurance to be effected. At the present time there were many firms who included insurance in the price.

He entirely agreed with what Mr. Atkinson said with regard to magnetos. The magneto was a particularly complicated thing, and if one had ever been landed on a high mountain top with a magneto, the magnetism of which had entirely disappeared, one would appreciate the difficulty of supporting its inclusion in the cars of the future.

With regard to the police, he thought the police of this country were the finest in the world. Being human, they were liable to make mistakes at times, but those who had motored in other countries would understand the extraordinary difficulty in which they were placed in having to take decisions at a moment's notice. Personally he had no sympathy with the man who railed at the police because once in ten years a policeman might lose his head.

White lines on corners would have to be dealt with on the lines suggested, but the only way to deal with pedestrians who would loiter at corners was to do what had been done at Amersham. He had had scores of lads before him in his capacity of Magistrate and fined them 5/-.

British manufacturers were apt to think in terms of the British Isles alone, but they would have to think, not only in terms of the Empire but of the whole world. In the past this country had gained a world-wide industrial supremacy, and should be able to do the same again so far as the motor car was concerned. It would be impossible to do it, however, with a 10 h.p. or 12 h.p. car. That was an admirable car for English roads, but in Africa, Australia and Canada it would be unsuitable. Personally he had interests in Australia and knew the type of thing that happened. A man would walk into a motor firm at Adelaide and be shown six examples of the woolly American car with a 10ft. 6in. or 11ft. 6in. wheel base. Beside that would be examples of all the British light, small cars. The man would say: "I do not want those; they are pups." It was not that the engine was not perfectly efficient, but a man like that would live 20 miles from a railway station, and he would have a car to take him home and he would put into it five trunks,

two sacks of flour, some bundles of something else, a calf, his wife and four children. The 10 h.p. engine simply could not tackle a job like that, and that was why at the present moment over 80 per cent. of the cars in use were of American manufacture. It was not because the people were not patriotic, but because the American cars were essentially suited to Australian conditions. The purchasers did not think in terms of nationality at all, and to secure their custom it was necessary to provide the type of vehicle they required.

However perfect the small car might be—and he thought it would sweep the American car off the British market in the next few years—it would not do for overseas purposes. It was only those who had had experience overseas, perhaps, who could appreciate the type of vehicle that was required there.

With regard to the absorption of British firms by American Corporations, that was a very dangerous feature, and he would like something done to prevent it. It would be found next year that with £18,000,000 of capital behind it the Vauxhall car—which was a first-class car—would be lowered in price in such a way as, if not to force competitors off the market, to make their prospects of profits very problematical. That would be extremely bad for British trade. Just at the time when the Vauxhall people happened to have produced a very efficient 6-cylinder sleeve valve design the firm was bought by an American Company. It was no use blaming the firm ; they had to do it or see no profits for many years, but it was a particularly dangerous feature.

With regard to super-chargers, he did not agree with the speaker who thought they should not be employed. The super-charger was the finest method of utilising the extra power of the cylinders to give a greater boost to the explosion, when one came to a higher gradient than the engine would normally take the car up on ordinary gear. Particularly in the case of the heavy commercial cars they would be very useful. Why there were so many steam vehicles on the road still was because steam in itself was a super-booster. It could give greater power at any given time to carry the vehicle over a hill where the ordinary commercial petrol-driven vehicle could not follow. If heavy commercial vehicles were fitted with a super-charger, and the engine correctly designed to stand its use, a very big step forward would be taken towards getting rid of the steam engine from our roads entirely, and giving an opportunity to our commercial petrol vehicles to obtain supremacy.

Obviously driving tests would have to be paid for, but there was no objection to that. Anyone who wished to go to the Continent would have undergone a driving test with a representative of the Automobile Association. The present charge was a guinea, and he was confident it could be done for 5/-. Far more care ought to be exercised than many drivers took at present, and he was not sure it might not be desirable to raise the driving age slightly.

On the motion of the Chairman a very hearty vote of thanks was accorded to the author for his paper.

NOTES ON BOOKS.

THE PRACTICAL BOOK OF TAPESTRIES. By George Leland Hunter. London : J. B. Lippincott Company. 42*s*. net.

Mr. Hunter states in his introduction that his book is based not on other books but on tapestries that he has seen and knows. At first sight this might lead one to fear that the work would be scrappy and incomplete ; but there is little reason for such apprehension, for Mr. Hunter appears to have seen and to know practically

all the tapestries of importance. His first example is a piece of Egyptian work of the fifteenth century B.C., and he carries the story right up to the present day.

Some of the finest pieces have found their way to America, notably to that great collector, Mr. Clarence H. Mackay. He possesses, for instance, the famous King Arthur and the Angers Apocalypse series, as well as what Mr. Hunter calls the finest piece in America, viz., the great Trojan War Set. All these tapestries are magnificent specimens, full of life and colour, while another excellent Trojan War piece is in the Edson Bradley collection, showing Odysseus and Diomedes at Priam's Court, whither they have been sent as ambassadors to demand the return of Helen. All the descriptive and historical part, which runs to about 230 pages, is written with admirable freshness, and it is copiously illustrated with many plates, some of them reproduced in colour.

The last portion of the book deals with more technical points, such as the texture, design and manufacture of tapestry. The final chapter on "Modern Tapestries," discusses some interesting points, particularly the question what exactly is the kind of treatment most suitable for tapestry design. Mr. Hunter puts his views so well that there is nothing for it but to quote his words :

> "We have the right to insist that tapestry designers shall create compositions lending themselves to interpretation in tapestry texture. This means that the compositions shall be well covered, like the compositions of great Gothic tapestries ....human figures and trees and buildings architecturally arranged with a maximum of vertical and a minimum of horizontal effects, with a minimum of shadows and a maximum of large line and colour contrasts—adjacent personages in contrasting colours, personages in the foreground pushed forward by personages and architecture in the middle-ground, personages and architecture in the middle-ground pushed forward by personages and architecture and landscapes, on a smaller scale, in the upper ground. The designs as a whole should be silhouetted, without attempt at sculptural presentations in the round. Tapestry texture can take flat designs and, through the magic of the bobbin, produce relief effects far stronger on a large scale than those of brush and chisel."

NEW INSTITUTE OF PLANT INDUSTRY AT INDORE.

A new Research Institute for the improvement of crops, at which special attention will be paid to cotton and to the fundamental problems underlying the production of this crop in India, was formally inaugurated at Indore in Central India recently. The foundation of the Institute has been rendered possible by the provision of a valuable site of 300 acres by the Indore Durbar, by a grant of two lakhs of rupees (about £15,000) for capital expenditure by the Indian Central Cotton Committee, and by an annual contribution of 120,800 rupees a year (a little more than £9,000) for current expenses in addition to the income derived from the land at the disposal of the Institute. This annual grant has been provided jointly by the Indian Central Cotton Committee and by seven of the Central India States (Indore, Dhar, Jaora, Datia, Rutlam, Dewas Senior Branch, Narsingharh and Sitamau). The control of the Institute has been vested in a Governing Body of six members with the Agent to the Governor-General in Central India as President. Three members of the Board of Governors are nominated by the Indian Central Cotton Committee, one by the Indore Durbar and two by the rest of the contributing States. The Director of the Institute will act as Agricultural Adviser to the States and will in this way come in direct touch with the Malwa plateau, one of the most important cotton tracts in India. The experimental area, which has been leased by the Indore Durbar to the Institute for 99 years at a nominal rent of £20 a year, embraces all the types of black cotton soilmet with in

India, and is very favourably situated for research work on crops. It is close to the city of Indore, now rapidly growing in importance as a commercial, manufacturing and educational centre, and to the cotton mills. The maintenance of an up-to-date library on crop-production and the training of post-graduate students, selected by the Indian Central Cotton Committee, will be features of the Institute. Mr. Albert Howard, C.I.E. (formerly Imperial Economic Botanist at the Agricultural Research Institute, Pusa), has been appointed Director of the Institute and Agricultural Adviser to States in Central India and Mrs. Howard (formerly Second Imperial Economic Botanist at Pusa), will be employed as Physiological Botanist at Indore.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 4..Child-Study Society, at University College, Gower Street, W.C. 5 p.m. Mr. Walter S. Rowntree, "The Childhood of the Race."

Geographical Society, 135, New Bond Street, W. 3.30 p.m. Mrs. Julia Henshaw, "The Mountain Parks of Canada."

Transport, Institute of, at Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30. p.m. Mr. J. Auld, "Some Recent Developments connected with the Shipment of Coal at South Wales Ports."
At the Town Hall, Leeds, 5.30 p.m. Mr. F. W. F. Oldfield, "Port Agency."

British Architects, Royal Institute of, 9, Conduit Street, W. 8 p.m. Sir C. Nicholson and Sir F. Fox, "Lincoln Cathedral."

Chemical Industry, Society of, Burlington House, Piccadilly, W. 8 p.m. Mr. A. W. Slater, "Coalescence."

TUESDAY, JANUARY 5..Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7 p.m. Mr. W. Ferrier Brown, "Sleeve-Valve Engine Development."

Photographic Society, 35, Russell Square, W.C. 7 p.m., Mr. F. C. Tilney, "Form and Content in Pictorial Art."

Metals, Institute of, at the Chamber of Commerce, Birmingham. 7 p.m. Dr. O. F. Hudson, "The Influence of Work and Annealing on Brass."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir William Bragg, "The Trade of the Dyer."

Anthropological Institute, 52, Upper Bedford Place, W.C. 8.15 p.m. "Exhibition and Demonstration of Archaeological Distribution Maps."

WEDNESDAY, JANUARY 6..Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m., Lieut.-Col. K. E. Edgeworth, "Frequency Variations in Thermionic Generators."

Geological Society, Burlington House, Piccadilly, W. 5.30 p.m. Mr. Vincent G. Glenday, "The Geology of the Suk Hills (Kenya Colony)."

Heating and Ventilating Engineers, at Caxton Hall, Westminster, S.W. 7 p.m. Mr. J. Roger Preston, "Pump Circulation."

Sanitary Engineers, Institution of, 120 and 122, Victoria Street, S.W. Presidential Address.

THURSDAY, JANUARY 7..Aeronautical Society, 7, Albemarle Street, W. 6.30 p.m. Prof. A. J. Sutton Pippard, "The Experimental Stress Analysis of Braced Frameworks and its Application to Airship Design."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Captain P. P. Eckersley "Past, Present and Future Developments in Wireless Telephony."

Linnean Society, Burlington House, Piccadilly, W. 5 p.m. Mr. Eric Marsden Jones, "On the Fertilization of Primula vulgaris Huds." Mr. M. A. C. Hinton "Persistent growth in the Water Vole and Old Age in the Wart Hog."

Metals, Institute of, at 85-88, The Minories, E. 7.30 p.m. Mr. J. Gough and Dr. D. Hanson, "The Fatigue of Metals: a General Survey and an Account of some Recent Work—Part I."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir William Bragg, "The Trade of the Potter."

Geographical Association, at London School of Economics, Houghton Street, Aldwych, W.C. 11.15 a.m. The Hon. W. G. A. Ormsby-Gore, Presidential Address, "The Economic Geography of the British Empire." 5 p.m. Prof. J. L. Myres, "Wayside Geography."

Sanitary Engineers, Institution of, at Caxton Hall Westminster, S.W. 7.30 p.m. Mr. Edward Willis, Presidential Address.

FRIDAY, JANUARY 8..Astronomical Society, Burlington House, Piccadilly, W. 5 p.m.

Geographical Society, 135, New Bond Street, W. 3.30 p.m. Mr. A. F. R. Wollaston, "A Naturalist's Journey to Ruwenzori."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m.

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mrs. Julia Henshaw, "Camping in the Canadian Rockies."

Philological Society, at University College, Gower Street, W.C. 8 p.m. "Survey of Philological Facilities."

Marine Engineers, Institute of, at Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 6 p.m. Third and Fourth Reports of the Marine Oil Engines Trials Committee.

Geographical Association, at the London School of Economics, Houghton Street, Aldwych, W.C. 10 a.m. Mr. A. G. Ogilvie, "South America and Africa as Fields for Geographical Research."
11.15 a.m. Sir John Russell, F.R.S., "Cotton and the Nile."
2.15 p.m. Sir Halford Mackinder, "The Teaching of Geography."
3.30 p.m. Dr. Vaughan Cornish, "The Rhythmic Flow of a River."

SATURDAY, JANUARY 9..Transport, Institute of, at the Town Hall, Newcastle-on-Tyne. 3 p.m. Mr. A. Hacking, "Some Financial and Political Aspects of Highway Development."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir William Bragg, "The Trade of the Miner."

Geographical Association, at the London School of Economics, Houghton Street, Aldwych, W.C. 10 a.m. Prof. P. M. Roxby, "The Concept of Natural Regions in the Teaching of Geography with special illustrations from China."

11.15 a.m. Mr. C. G. Beasley, "The Place of Geology in a Two Period a Week Geography Course." Mr. C. Daryll Forde, "Detail in Geography Lessons." Major A. G. Church, "Geography in relation to other School Subjects." Miss R. M. Fleming, "Geography for the Younger Children in Primary Schools."

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FRIDAY, JANUARY 8th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 13th, at 3 p.m. (Dr. Mann Juvenile Lecture.) The second Act of a presentation of *Alice in Wonderland at the Breakfast Table*, by PROFESSOR HENRY E. ARMSTRONG, F.R.S., aided and abetted by Alice, Mac Hatter, the Dormouse, the March Hare, Brer Rabbit, the Cook, the Duchess, Father Christmas, and Tar Baby.

OPEN COMPETITION OF INDUSTRIAL DESIGNS.

The third annual Open Competition of Industrial Designs will be held in June next, and full particulars can now be obtained on application to the Secretary of the Royal Society of Arts.

Competitions will be held in the following sections :—Architectural Decoration, Textiles, Furniture, Book Production, Pottery and Glass, and Miscellaneous. In addition to a large number of money prizes, a Travelling Scholarship is offered in the Textile Section.

It is intended to confer the Society's Diploma on any candidate whose work reaches a very high standard of artistic ability and also shows practical knowledge of the materials and processes of his trade.

After the work has been judged a number of selected designs will be exhibited in London, and subsequently at suitable centres in the provinces. In this way they will be brought immediately to the notice of those manufacturers who are likely to be specially interested in them.

The Council hope to place the Scheme on a permanent basis and to offer annually travelling scholarships and prizes. In order to secure this object a very substantial capital sum will be required. They therefore appeal to all those who not only are interested in the artistic industries of the country but are concerned for the general improvement of British trade, to assist them in promoting the Scheme. Contributions to the Fund should be addressed to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

PROCEEDINGS OF THE SOCIETY.

INDIAN AND DOMINIONS AND COLONIES SECTIONS.

(Joint Meeting.)

WEDNESDAY, DECEMBER 9TH, 1925.

THE HON. W. ORMSBY-GORE, M.P. (Under-Secretary of State for the Colonies) in the Chair.

The paper, which, in the absence of the Author, was read by Dr. Arthur William Hill, Sc.D., F.R S., Director, Royal Botanic Gardens, Kew, was :—

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE,

By H. MARTIN LEAKE, M.A., Sc.D., F.L.S. (Director of the College).

The theme this afternoon is the Imperial College of Tropical Agriculture. It may be approached from several directions. It is an Educational Institution, and I might introduce it to you as such, describing the courses taken, the students who attend, and the qualifications they may derive from their attendance. It is also an Institution for research, and I might describe the facilities for such work. Again, it is situated in one of the most beautiful islands of the world, the scenery of which has been made famous by Kingsley, and I might commence with a description of its setting. None of these, however, appeal to me for the purpose of introduction. The College is specialised and offers a training and education which will adapt students for a particular service in after life ; it is also Imperial, and its appeal is to the Students of the Empire. If, therefore, I am to place the College before you in its true perspective, it appears to me that I must begin with the Empire, and show what are the needs which the College is particularly designed to meet and how it proposes to meet them.

The development of the British Empire is a historical fact and must be considered from the aspect of history. Its condition is never static, and those who are responsible for its guidance must throw their thoughts into the future if that guidance is to develop the *corpus sanum* necessary to a contented congeries of communities. But it is equally important that development shall be evolutionary, and inasmuch as the future arises from the past through the present, no guidance which ignores the past can be based on a sound foundation. What then is the past on which the future depends ? Very briefly the relevant facts appear to me to be these.

We have just celebrated the centenary of the first railroad, and it is difficult to believe that only one hundred years ago travelling was limited on land to the coach on indifferent roads, to the saddle horse or, in places, to the feet, while at sea it was limited to the sailing vessel. The harnessing of power through the steam engine is the central fact which has rendered the development of these years possible, and it is especially to the adaptation of the steam engine to transport that we must look for the explanation of the extent to which

this development has proceeded. It is true that the steam engine is responsible for the rise of the factory as we know it, but such a development would not have been possible without transport facilities to bring raw materials in bulk and to distribute the manufactured products. The factory system, which has developed as the result of what is commonly known as the Industrial Revolution, has led to the enormous increase in population of recent years, to its redistribution and aggregation in large cities which are dependent for the means of subsistence on an interchange of goods.

The results of this hundred years of progress are most apparent in Britain where not only the individual cities but the entire country is no longer self-supporting in the mere essentials of living. More than this, it is not self-supporting in the raw materials by the conversion of which into manufactured goods and by the sale of which, when so converted, it is enabled to purchase those essentials. It is, probably, only in Egypt that a counterpart to these conditions is to be found.

I would, however, go further than this and say that the same conditions are rapidly arising throughout the temperate zone. America, till recently a country crying for population, has already reached the stage when she views an excess population as a danger which must be guarded against, and she is making her immigration laws more stringent. Japan in like manner has a population for which she has to seek an outlet outside her shores. We are, in fact, at the threshold of a development which will receive greater and greater recognition with each successive year; it is no less than the organisation of production in the less populated and more productive portions of the earth's surface, namely, the tropics, to provide the essential needs of the densely populated temperate portions of the globe. And, inasmuch as it is England which is the least self-supporting of all countries, it is to England that we would look for the lead in this development. Nor is she ill situated in this matter. She owns and administers vast tracts of productive land within the tropics which at present yield but a tithe of their latent capacity. If her population is to retain the *corpus sanum* essential to contentment she must develop these areas, or she will lose the position she has attained and now holds among the nations.

I pass, then, to a consideration of how this development is to be effected. As Professor Knowles has shewn, arguing from the historical aspect, Colonial development has proceeded on definite lines which have been dictated by the same agency to which reference has been made above—namely, transport. As long as land transport was limited to the beast of burden or even to man as a porter, as in Africa, penetration and development was limited to islands and the coastal tracts; the extraction of the wealth of the hinterland remained a practical impossibility. The interior had necessarily to await, and in many cases, still awaits, opening up by more certain means of transport before the potential wealth can be placed at the disposal of those crying aloud for it.

Transport is thus the key to the situation, and this has nowhere been more clearly recognised than in the recent report of the East Africa Commission. But if it is the key, it is not the sole requirement if full advantage is to be derived from these areas. A key may be essential to open the cupboard, but the starving man will not benefit much from its possession if the cupboard be bare. I would direct your attention, therefore, to the necessity of insuring that the cupboard be well stocked when opened.

This leads me to the subject with which we are more directly concerned this afternoon. These areas are, and must remain, as far as we can see, agricultural and their development must be based on agriculture. But, again, progress must be evolutionary, and we must consider the present position in those tracts if dislocation is not to result. It is not possible, here and now, to deal with special cases and I must confine myself to broad outline. So considered, there is, throughout such areas, a population on the land; a population with an organisation usually tribal, which includes among its customs a more or less clear recognition of rights in the land. In cases where the indigenous population is very sparse and where the country is suited for a permanent white population, expropriation may be justifiable, for, as the East African Commission recognises, there is a duty to observe to mankind as a whole as well as to the local community. As I have stated elsewhere, the world has grown too small to justify a small community claiming the right to occupy a large area unless it undertakes development. But if expropriation, which means the appropriation of land by aliens and the reduction of the population to the position of wage-earners, be not possible, what is a possible development? Economic agriculture for the production of produce which finds its market outside the country involves bulk production, for which not only is the backward population unsuited and the unit too small, but capital is an essential.

This is the problem, but at the back of it all is the inhabitant of the country who must remain the ultimate producer. He has to be organised to produce without losing his status as a land owner; he has to be provided with seed if the produce, when bulked, is to possess that uniformity which alone finds favour on the home markets; and he has to be taught better methods than those of his ancestors.

The dependence of the temperate zone on the tropics is no new phenomenon, it is a dependence which has become more and more marked with the years. But, till the war, the change had been so gradual that it is doubtful if any but a few really appreciated the trend of affairs in this matter. The war has wrought an economic upheaval which has thrown a searchlight on many such changes and which must hasten these. Can it be doubted that, if the cupboard is to be found well stocked when the key of transport is provided, we must take steps to make it so, and can it be doubted that one of the essential needs will be trained men? Trained men are required to organise the collection and preparation of produce for the market; trained men are required for the

organisation of seed supplies ; and trained men are required for the instruction of the backward tiller of the soil. Nor is this the limit of the demand for trained men. Agriculture for its success depends on the adaptation of the plant to its surroundings. It is not possible to enter a tract and from *a priori* considerations state what will be the best agricultural practice : this is the result of a process of trial and error. In old countries that practice is the result of a long series of such trials conducted in a way which is so far from being recognised as such that it is usually termed tradition. In new countries where tradition has not built up a fundamental practice this has to be established by other means, for events are moving too rapidly to allow of such a slow process, and these means are what are termed experimental. Again, this is work for trained men.

I may carry this line of thought yet another step. If we have found our crop suited to the conditions, and if we have found the best method of growing it to maturity, there may yet be a slip between the cup and the lip—something may intervene, a plague of locusts or a fungoid attack, to prevent us from reaping the reward of labour. The essential need for studying the diseases of agricultural plants is one which has been treated by abler hands than mine—those of the Chairman of our Governing Body, Sir Arthur Shipley—and I will only emphasise his conclusion, namely, that trained men are required to keep such pests under control.

I may proceed still further. Few, very few, systems of agriculture can ignore the utility of farm stock. At some stage or other, even if only as a source of manure, their intervention is required. Is not the low acreage yield of wheat in Canada, for instance, in part due to the small part cattle play in the agricultural economy of that country ? But cattle also are subject to disease and the type of cattle has to be adapted to the particular use to which they are put and the particular conditions under which they work. Again, trained men are required to evolve the type and to protect the stock from disease. And lastly, there is the human element. Ultimately the prosperity of a country depends on the health of the population. In the tracts under consideration there is practically complete ignorance of the simplest rules of health, and there is urgent need for trained men not merely to inculcate the principles of sanitation but to study the diseases peculiar to those tracts.

But I hear it said, you have dealt at length with the hinterlands, with those tracts, that is, which your key of transport has opened up; what about those islands and coastal tracts which were the first to receive attention ? Have you forgotten these ? These have certainly not been forgotten. If I have left them to the last it is because of their, if anything, greater interest. We have here no elementary conditions but a complete economic system which will require even greater care and study if the full productive capacity is to be attained. Perhaps the best indication of this complexity is given by a consideration of the crops grown. They are such as tea, rubber, cacao, coffee and citrus, of which the main characteristics are their permanence and slowness

in reaching maturity. It is this characteristic which makes them capitalistic crops and removes them from the sphere of general agriculture. They are aptly termed orchard or plantation crops as opposed to field crops. Sugar and bananas form an intermediate group. These attain the productive stage relatively early but their cultivation involves much labour and expense and, for full productivity, they are best considered capitalistic crops; nevertheless, the conditions under which these, and especially sugar, are cultivated throw a special light on the point I wish to emphasise here.

A sugar factory has to distribute its overhead charges and is economic only when handling a large amount of cane, to produce which an area anything over 1,000 acres must be under cane. This may be directly raised by the factory employing steam cultivation and paid labour. But in many instances, only a part of the need is met in this manner, the remainder being met by independent "cane farmers" who grow cane on their own land and sell to the factory. It requires little acquaintance with the practical working of the system to see that there is a vast divergence between the acre production under the two systems, that of the cane farmer being on the average probably as low as fifty per cent. of the yield under estate cultivation. To what is this divergence due? It is not soil, for there is no selective distribution, and it is not climate. There are underlying economic conditions responsible for the phenomenon and until these have been studied, and until the yield under the two systems is equalised, there is a field for improvement. To get that improvement, however, trained men who understand the economic principles and their practical solution are required on the estate.

On the estates themselves the need for trained men is equally great. Competition is growing yearly; the Dutch Rubber Estates have enhanced the supply of raw rubber; the development of cacao in West Africa has produced a similar result in the supply of the cocoa bean and the supply of palm oil and copra is rapidly increasing with the introduction of the plantation system in the East. Tea alone remains comparatively localised. Estate management is thus becoming more and more skilled, and success will be dependent not only on farming skill but on careful accountancy.

Throughout, then, from the practical aspect, the business of Agriculture is requiring greater skill which only training can provide, whether that business takes the form of the estate or plantation, or whether it takes the form of organised production through smaller units. Training is also required for the investigation of conditions, for the evolution of races adapted to the conditions, and for the study of disease; and where is this supply of men so trained to come from? I have heard the view expressed that an officer appointed to an agricultural service in the Tropics does not earn his salary for the first two years of his service. During those two years he is learning, and adapting himself to his new conditions. If this be a correct estimate, clearly there is much to be gained by an introductory year at an institution situated within the tropics

and offering to students facilities for training under conditions similar to those in which they will work in future. It is true this adds an additional year to the student's non-earning life, but it has to be recognised that the days of the 'Creeper,' to use a Ceylon expression, are over. Agriculture is becoming more and more a profession and an additional year cannot be grudged for such a purpose.

At the present moment there is only one institution within the Empire offering these facilities and it is of very recent origin; it is the Imperial College of Tropical Agriculture in Trinidad. This College started its career in 1922 as the West Indian Agricultural College, a body registered under the Companies Acts of 1908 and 1917. It is impossible here to record its history in any detail; this is intimately connected with that of the Imperial Department of Agriculture for the West Indies, which was organised as a result of the Royal Commission of 1896, and the College owes its existence in great measure to Sir Francis Watts, its first Principal, who, as Commissioner of Agriculture for the West Indies, inspired to action the group of imperially minded gentlemen, whose names are appended to the Articles of Association. In 1923 the question of stabilising the finance of the College arose, and at the instigation of the Rhodes trustees, who have contributed liberally to the funds of the College, the title was changed to that of the Imperial College of Tropical Agriculture. In the short time of one year the wider scope for a College of this nature had become apparent and this change of name accorded both with this extended field for usefulness and with the wider appeal for funds. But if the basis of the College be Imperial it must not be forgotten that it is to the West Indies that the credit is due for the very existence of the College and they have their reward in its location in their midst. Undoubtedly local conditions enter largely into any agricultural problem, and all work carried out at the College is subject to those conditions.

I have in my earlier remarks defined the functions of the College in broad outline. Let me now try to explain how that object is to be achieved. Medical and Veterinary training is provided by specialised colleges whose educational work no Agricultural College can adequately undertake, though there is an opening at such a college for that less technical instruction, which every agricultural officer should possess, as well as for research. Apart from these the character of training requires to be adapted both to the student who desires to take up the practice of farming under tropical conditions, whether he does so directly or indirectly; to the student who enters the so-called administrative side of the Colonial Agricultural Services, and to the student who specialises on the research side with a view to entering the investigating side of those institutions. Now if a student is to become of value to a Colonial Department, or even to some of the larger Development Companies, it is essential that he should be, during the latter portion of his training, in an atmosphere of research. Research, therefore, is an essential feature of the College. It is not possible to draw any

fast distinction in the matter of agricultural research, but, broadly speaking, there are problems of local importance and problems of wider, or fundamental, importance to be investigated, and those of the latter kind are, fortunately perhaps, infinite in their variety. That this is a distinction which is receiving wider recognition with time is indicated by the establishment by the Empire Cotton Growing Corporation of a research station for cotton in proximity to the College. It is to such problems that the staff mainly devote themselves, and the post graduate students are encouraged to take an interest in this work and, in the case of those whose object is to continue at research, even to undertake investigations of such a scope that the results may be available within the term of their residence. In the case of those whose aim is the more practical side of agriculture, attention is directed to that aspect, and here special stress is laid on the economic and business aspects.

Again, we do not overlook and forget our origin as a West Indian College. For education of a University status a West Indian student has to proceed abroad, either to England or, as is frequently the case, to America. Schools, however, exist which teach up to matriculation standard and the College, therefore, has instituted a Diploma Course of 3 years which, open to any student who has qualified in an accepted matriculation examination, has a University status and any successful student is eligible to proceed to a fourth year post-graduate course. The West Indies, therefore, are in possession of an educational institution at which their youth can qualify for the highest posts without the expense of years in England or America. Nor is this course limited to West Indians. It is open to any student who holds the matriculation qualification of any University in the British Empire.

Such are the facilities offered, and I can say without fear of contradiction that, owing to the foresight and breadth of vision of those who have guided the fortunes of the College, the charge I have recently taken over provides opportunities to students which are unique. I suppose no one is contented in this world and our wants are still numerous. The staff is ridiculously small, and has to make up in energy what it lacks in numbers; residential accommodation for students is urgently needed, and an estate run on business lines is essential for the full development of the practical courses. But, in spite of these deficiencies, I think I may claim that the College has achieved for itself a position which will become widely recognised at no distant date. So far numbers are small. For the session 1924-25 33 students were in residence. In this year, for the first time, Diploma students, 5 in number, completed the 3 year course, and of these two are taking a 4th year course. Students have been sent each year by the Empire Cotton Growing Corporation to take a year's post-graduate course, while 4 probationers for the Gold Coast Agricultural Service were sent in 1924 for a similar course. Now that the recommendations of the Milner Committee have materialised, a year's course at the College will form a necessary preliminary for the Colonial Agricultural Service. These

numbers, however, are as nothing compared with the demands on our services which the future seems likely to bring forth. The pressure on tropical development is increasing yearly, and is only restrained by the post-war financial stringency; the economic pressure of competition is compelling the adoption of more highly skilled methods and staff, and when the extent of the Colonial area is considered, I begin to feel, with Sir Arthur Shipley, almost afraid of the future before us. We have here, in fact, unless my vision of the future is entirely fallacious, one of the very few expanding fields for the youth of the Empire.

I have spoken of agriculture as a process leading to the production of raw materials. This, however, is not universally true. Many crop products have to be worked up partially or completely before they can be marketed. Especially is this the case with sugar, and the working up of sugar from the cane is a complicated process of a highly technical character. Courses are given in the principles underlying the preparation for market of the main tropical crop products but, owing to the generosity of the sugar manufacturers a complete "model factory"—in reality very much more than a "model," for it can turn out over two tons of sugar per day— has been attached to the College. There are, therefore, attached to the College facilities for a complete course in Sugar Technology, which for a student with a preliminary knowledge of Chemistry takes two years. I cannot leave this subject without a word of regret at the recent death of Mr. Berthon who gave his services freely to the design and to the superintendence of the erection of the factory. It is not too much to say that the generous gifts of the sugar manufacturers would not have produced the co-ordinated whole which we have, and which is unique in the British Empire, without the untiring services of Mr. Berthon, and no one can but regret that he should not have lived to see the full fruits of his work.

Before I conclude I should like to throw out one further suggestion. If a general survey be made of the Colonies which lie within the tropics, what is the fact that strikes the mind most forcibly? To my mind, at any rate, it is that for an indefinite period their prosperity is bound up with agriculture which is directly concerned with the land. Land tenure, it is true, is not purely, perhaps not even mainly, an agricultural problem; it is an administrative, and it may even be a political, problem. Yet it is the foundation on which agriculture must be built and the prosperity of the agricultural community depends. I come from India and I come from that province which has, perhaps, the most complex system of land tenure of any, and this may be the reason why I attach so much importance to the subject. Throughout the Colonies we find every variety of land tenure and we find in each a different and often a varying policy. Such a practice cannot lead to sound development. Sound development requires, as I have shown, the co-operation of labour with capital which latter must, for the present, come from outside. This co-operation can never arise without security to the cultivator that he will not be expropriated, and

security to the capitalist that he may build on an assured future. The general principles of land tenure require to be worked out and their local application established as a continuous policy. I can think of no country where the varied conditions can be so readily studied at first hand as in Trinidad, and I cannot help feeling that a leaven of officers, distributed through the administrative services and trained at a place where such subjects are under investigation and can be demonstrated practically, can do nothing but good. I visualise the College, therefore, as one of the recruiting grounds for the Colonial Administrative Services, and should that vision ever materialise, the College will have yet a wider field of utility than that I have sketched for it in the earlier portion of this address.

DISCUSSION.

THE CHAIRMAN said the audience had listened to an extremely valuable paper, which revealed the Director of the College—despite the fact that he must necessarily be immersed in the actual local organisation of the College—as a man of singularly wide outlook on the relation of the problems which he had to face day by day to the needs of the Empire and of the world. Personally, the more he saw of this particular question from the angle of the Colonial Office the more important it became to his mind. We could not possibly develop those huge tracts in East and West Africa which were under the charge of the British Empire unless there was a considerable stream of men available, both as agricultural officers and in the case of East Africa as settlers possessed of a better scientific knowledge of how to tackle the problem of tropical development. The author had touched on the question of native production. For climatic reasons it was obvious that West Africa, for example, was destined to be practically entirely based on native production. Although wonders had been achieved in a comparatively small space of time in the development of native production, there were quite definite limits unless the native cultivator could be continually assisted by properly trained European scientific officers. Nothing would be more disastrous to our relations with the native if, after encouraging him to acquire wants and needs, and after having started him on the road to making money in order to satisfy those needs and develop a trade, he should then find that his crop was wiped out in the markets of the world owing to lack of quality or disease. Therefore it became all important that at every stage in native progress and production the aid of the scientific agriculturist should be brought in. One realised that some people sought to oppose and to contrast what might be called the plantation policy and the native production policy. His own view was that for the adequate development of the world, both were necessary, and varied according to climate and circumstances; but those who pointed out the success of the plantation policy must realise that, just as there was a limit to the success and efficiency of the native production policy, so there was almost the same limitation to the plantation policy. The success of the plantation policy in the long run depended upon the personal efficiency of the planters and managers. He did not believe that in the coming race in the world the plantation owners and managers could afford to neglect the scientific side, and that if a man wished to succeed in the production of tropical crops it was essential that he should have the means of training.

Successive British Governments had rightly attached great importance to the hope that the College should never become a purely State institution and purely

State-supported. They were acutely conscious that something of the freedom and the traditions of higher education in this country must be established in connection with the College if it was to be the permanent success which it was hoped it would be. He hoped the British Government—and all Governments throughout the Empire—would, in course of time, be induced to give some modicum of financial support to the College. No Colony and no Protectorate, and least of all the Mother Country, could afford to do without such an institution. He was sure it would be a very severe blow to such a great Imperial project if any of the neighbours of the College were to fail to support it. It was a project in which the whole Empire was interested, and not only in the immediate interests of each Colony but in the interests of the Empire as a whole it was very important that it should receive adequate support. Having said that, he hoped that the College would not look entirely to the support, and therefore very largely control, of the State, and that more commercial people—those whose welfare in trade was bound up with Imperial development, and those whose industries were more and more dependent upon tropical materials—would come forward and take a lively and personal interest in the success of the College. The College was singularly fortunate in having a man of Dr. Martin Leake's personality as its Director, not only on account of his enthusiasm for the technical work, but also because he combined with that the qualities of a leader of men and more particularly a leader of young students—which was very important.

Under the new recruiting scheme in connection with the Colonial Agricultural Services, the College had become an integral part of the machinery. All those considerations made one long to rush at it and made one anxious to go forward at almost break-neck speed, but there must be one word of caution there. It was essential, if an Institution like the College were going to be ultimately sound, that it should be by a process of organic growth. There might be a danger, seeing the enormous field before it, and the tremendous variety of crops at its disposal, that a College of this kind might attempt in the early years to do rather too much. Its chief successes would be won if it went step by step, sending out throughout the world a growing volume of students whose worth was recognised and who, by their previous association with Trinidad, were able to spread the traditions and knowledge of the College throughout the Colonies and the Empire. With such a growth, necessarily slow, the College might in due course, become the headquarters for University teaching in applied agricultural science for the whole tropical Empire.

Lieut.-Col. Sir David Prain, I.M.S., C.M.G., C.I.E., LL.D., F.R.S., said that twice in the course of the lecture the author had laid stress on the fact that although the College was an Imperial College it was also a West Indian College. Not very long ago he personally had had occasion before the Royal Society of Arts to say that it was extremely interesting to know that we owed to the West Indies the movement which had led to the establishment of scientific institutions such as botanic gardens throughout varions parts of the Empire ; and only the other day the Chairman of the Council had reminded us that, after all, the impetus in that direction in the first instance had come from the Society of Arts, as it was then. So in founding the College the West Indies had only been continuing the attitude towards matters of that kind which they had entertained for a century-and-a-half.

He was very glad to hear that the author thought that one year in the College would be as good as two years of practical experience in the tropics after a man had been trained in this country. Some people might ask, why should one year

be enough at the College if it took two years of actual experience in the field to produce the same effect? In his opinion the author in that particular instance had rather understated the case. As a matter of fact when one did find oneself in the Tropics one discovered at the end of six months that one knew all about things; at the end of six years one began to think there was just the possibility of having made mistakes, and by the time they had had 20 years' experience in the Tropics most men knew thoroughly well that they did not know anything at all. One year in a College was a period in which one could get, with good advice at one's elbow, a great deal of knowledge, and one had not to unlearn much that one took out after having been trained in this country.

As one who had served the Government for more than 40 years he would like to endorse what had been said by the Chairman as to the inadvisability and undesirability of any institution like the College having more to do with Government than it could help. At the same time, as the Chairman had been so kind as to say that perhaps some modicum of support might come from Government, might they be asked on behalf of the College to remember that "*bis dat, qui cito dat.*"

SIR EDWARD DAVSON, President, Associated West Indian Chambers of Commerce, said as a Governor of the College it had been his privilege to go to Trinidad and see the good work which Dr. Martin Leake was carrying on there. He congratulated the College on the fact of having a man of such wide vision and imagination as Dr. Martin Leake, as its Principal. One of the most interesting things in the development of our tropical Empire in the recent past had been the great growth of the scientific attitude towards agriculture, but it was only now that we were seeing the formation of an Institution which would directly instruct and teach those who were going to take up their work in tropical parts. He viewed the matter, not as a scientist, but as a layman. He was connected with tropical agriculture and he had been trying for some time to find an agronomist, a scientific agriculturist, who had had experience of tropical agriculture, whom he could employ to assist those who were working on the properties with which he (Sir Edward) was connected; but he regretted to say that so far he had been unable to find any one at home who was qualified for that post. On the other hand he had had a great many applications from Americans with University qualifications and with experience of tropical agriculture. He thought it was a sad reflection that America, whose tropical Dependencies were fewer than those of this country, should have apparently the necessary men available. He thought it was also regrettable that at a time when we did not know what to do with the young men of the present age there should be posts open, such as the one he had just referred to, carrying a salary of £800 to £1,000 a year, which the young men of our country were not at the present time able to fill. Therefore, he welcomed the work of the College, because he looked to it in the future to supply young men of the type required to fill such posts.

The scientific spirit must be applied in an increasing degree to the field of agriculture. In the past agriculture had been built up by trial and error and by practical working and experience. Without that practical experience, of course, no amount of science was of any value, but it was necessary to see a happy combination of both. He looked forward to the future when all these tropical industries would be considered as scientific professions—or, if not that, at least as professions for which it was necessary to prepare by undergoing a preliminary course of instruction in the elements of agriculture. He hoped in the future the young men to be employed as overseers, and who would eventually become managers, might in the first place

qualify themselves for those posts by undertaking a year's course at the College and possibly returning from time to time and continuing their studies.

Tropical agriculture was going to be a more and more important matter to this country, and the more we could make it efficient, and the more we could produce at the lowest cost the more this country would benefit.

MR. EUGENE RAMSDEN, M.P., said he had just recently had the pleasure of visiting the College. He had gone out there as a sympathiser with the work which was being done, but since he had seen the College and the way in which the work was to be carried out, he could state quite frankly that he was now an enthusiast in the cause. Although the West Indies could always claim the credit of having initiated the movement, it was a College which would have to deal with a very much larger portion of the British Empire than the West Indies alone. He congratulated the governing body of the College in having secured the services of Dr. Martin Leake, who was not only going to turn out experts in agriculture but who was going to turn out men.

Unless we used science the development of our Crown Colonies and of the tropical Empire was going to be very slow indeed. There was an opportunity of doing very great things with the College, and he hoped it would receive the support, not only of those interested in the question, but also of the Government. It was a College of such Imperial importance that it should receive assistance, not only from the Government of the United Kingdom, but from the Governments of the different Colonies. He desired to lay special stress upon an exceptionally pressing need of the College, namely, the question of suitable accommodation for the students. The provision of a hostel was of the very greatest possible importance, and he hoped that sufficient money would be raised at once for that purpose.

PROFESSOR J. B. FARMER, F.R.S., also stressed very strongly the need of a hostel for the students. Anybody who knew anything of the prevailing conditions would put that as one of the College's very first requirements. It is one of the most extreme urgencies of the situation, and unless it is speedily met the future of the College will be seriously jeopardised.

MAJOR H. C. CORLETTE, F.R.I.B.A., said it had been suggested to him that a few words on the subject of the building might be of some interest. Sir Arthur Shipley and the governing body had always taken a wide view of what the requirements in the way of buildings might be. The building shewn on the wall that evening really represented only a first portion of what was proposed to be built. Although it might appear to be of some size, there was a considerable number of departments essential for the working of the College which could not be housed in it. Physics and sugar technology, mycology, botany, chemistry and entomology were all at present being dealt with in a more or less temporary fashion in buildings which were not in any sense permanent. The College had been designed so as to be suitable for tropical conditions. The idea had been to provide all the light that was necessary and to veil the students as far as possible from the direct rays of the sun by providing verandas on the east and west sides. The laboratories were of a considerable height—about 14 feet—so as to keep the students cool while they worked, and there was provision for allowing the air to pass through the buildings if at any time it might be necessary to keep the windows closed. He hoped it would be realised that the work could not be carried on without a certain amount of expenditure. In these days science could not be taught without properly equipped buildings.

Mr. Ormsby-Gore having to leave the meeting to keep another appointment, then invited Mr. Algernon Aspinall, C.M.G. (Secretary, Imperial College of Tropical Agriculture) to take the Chair.

Mr. Algernon Aspinall, having done so, remarked that perhaps the most useful contribution to the discussion he could make would be a brief statement regarding the financial position of the College, which was certainly causing a very great deal of anxiety. The College owed its inception to the West Indian Colonies which, with one or two exceptions, had come together and most generously contributed one-half of one per cent. of the revenue to the support of the College. It was hoped that before very long Jamaica might also come in. The Colony of Trinidad had not only given one-half of one per cent. of its revenue, but also £50,000 wherewith to erect the buildings. That money had already been spent to advantage because buildings had been put up which it was hoped would stand for all time. Gifts had also been received from other quarters towards the building. Now the authorities were looking to other Colonies in the Empire for support. Students had already been sent out to take up appointments in the Sudan, Uganda, Nyasaland and the Gold Coast, and it was hoped that in due course contributions would be received from those Colonies and countries. It would be remembered that the late Lord Milner had inaugurated a fund with the object of providing means for equipping laboratories, building a hostel, and providing an estate, which were so essentially needed, but owing to the Japanese earthquake and the threatened fall of the dome of St. Paul's, the response to that appeal had not been so good as had been hoped ; but the College had received £29,000, and it was hoped that further contributions would be received when the good work of the College was known more widely. The Rhodes Trustees had given £5,000, and he was hopeful that there might be present some ladies and gentlemen interested in tropical agriculture who would follow that excellent example. He particularly endorsed the remarks which had been made about the need for money for a hostel. If money was not forthcoming for that purpose the work of the College would be very seriously checked, if not jeopardised. By October 1st, 1926, accommodation had to be provided for 30 more students, and at present the governing body were in the awkward position of not being able to do that ; they simply had not the money. Therefore it was thought H.M. Government should make a contribution, not only of the capital sum for the purpose of the erection of an hostel, but also an annual sum for maintenance. The matter had become one of the very greatest importance if the good work of the College was to continue unimpaired.

Dr. J. A. Voelcker, B.Sc., Ph.D., in moving a vote of thanks to Dr. Martin Leake for his paper and to Dr. Hill for having read it, said he was sure he spoke on behalf of the Council when he said that everyone was delighted that the present meeting should have taken place. It would be a matter for gratification to the Council of the Society to know that they had had some indirect connection at least with the College in Trinidad. All who were interested in scientific agriculture must have a great desire to see the College prosper and its good work continue. One was glad to hear that the work would go on on the right lines, namely, on truly scientific lines. In this country we had, after a good deal of struggling and trying one thing after another, hit on something like a scientific agriculture ; but there was this great difference between the agriculture of our country and the agriculture of the West Indies, namely, that agriculture in this country did not pay,

whereas in the West Indies there was at least a prospect of some profitable outcome from it.

PROFESSOR H. E. ARMSTRONG, F.R.S., in seconding the resolution, said that undoubtedly there was the very greatest need at the present day for education of the type which was foreshadowed in connection with the College, always bearing in mind the caution which Sir David Prain had given, namely, that scientifically trained people always learned in the end that they knew less and less of the subject they were practising the more they got into contact with practical men.

He thought the remarks of Sir Edward Davson were of the greatest importance. One wanted to know why it was that we were not producing men in this country at the present time who were fit for anything. That was true in all branches, and not only in one. He had had the opportunity of recommending men to posts of importance in the last few years in India and elsewhere, but he had not been able to find the men of the quality required to fill those posts. So far as the Indian posts were concerned the difficulty was to find men who had the courage to go out. We had made our position in the days gone by in India and in the Colonies generally through our courage and through our individuality. Those qualities were being educated out of our youth at the present time by our system of examinations in the schools to a large extent. One had always to recollect that a vast number of young men had been lost in the war, and it would take generations to recover the stock, but those who remained were for some reason not being trained up with the courage and with the individuality which was required for work of that kind, and if, as had been stated, the head of the College was able to turn out men, he was doing far more than if he were merely turning out men who were scientifically trained in the narrow sense of the term.

MR. ASPINALL mentioned as an example of what Dr. Armstrong had just said that there was a prospect of having temporarily to close the sugar school next Session, because there could not be found within the British Empire a technologist to carry it on.

The vote of thanks having then been put and carried with acclamation, the meeting terminated.

INDUSTRIAL STANDARDISATION IN NORWAY.

The Norwegian Industrial Association introduced a plan last October for the standardisation of all industrial commodities produced in Norway, and established, with the help of Government and private subscriptions, a standardisation committee to operate for about three years.

The Norwegian Government has recently established the standardisation office, which is an outgrowth of the activities of the Industrial Association. This office will investigate standards in use at home and abroad with the object of adopting those that are applicable to Norwegian industries. Its efforts will centre in effecting greater uniformity in the dimensions, patterns, and quality of the country's products. By co-operating with producer and consumer, the office hopes to ascertain and abolish variations of products unnecessary for normal requirements; to introduce uniform description of articles; and to eliminate ambiguities in sales and purchase contracts.

The first two matters to receive attention, writes the United States Acting Commercial Attaché at Copenhagen, will be the standardisation of paper sizes and the uniform execution of technical drawings. Subsequently, all other products will be considered with the idea of reducing production costs, and giving the consumer goods of greater practical usefulness.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 p.m. :—

January 20.—H. Houlston Morgan, Ph.D., B.Sc., F.C.S., President, Oil and Colour Chemists' Association, "Problems in Paint and Varnish Technology." Sir Frank Baines, C.V.O., C.B.E., in the Chair.

January 27.—Professor John McLean Thompson, D.Sc., F.R.S.E., Professor of Botany, University of Liverpool, "Some General Problems of the Transport by Sea and Conservation in Store of Ripe Fruit." (Aldred Lecture.) Sir Halford Mackinder, Chairman of the Imperial Shipping and Imperial Economic Committees, in the Chair.

February 3.—Sir Edward John Russell, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station, "Investigations in Agricultural Science at Rothamsted." The Right Hon. Lord Clinton, Chairman, Lawes Agricultural Trust, in the Chair.

February 10.—Professor J. C. Drummond, D.Sc., F.I.C., Professor of Bio-Chemistry, University College, London, "Modern Views of Vitamins."

February 17.—James Edward Taylor, M.I.E.E., Superintending Engineer, Post Office Telegraphs, etc., South Midland District, "The Propagation of Electric Waves." Admiral of the Fleet Sir Henry Jackson, K.C.B., F.R.S., in the Chair.

February 24.—Mrs. Mary Fishenden, Fuel Research Board, "Domestic Heating."

March 3.—Percy Dunsheath, O.B.E., M.A., B.Sc., M.I.E.E., Chief of Research Department, W. T. Henley's Telegraph Works, Co., Ltd., "Science in the Cable Industry." Llewellyn B. Atkinson, M.I.E.E., past President of the Institution of Electrical Engineers, in the Chair.

March 10.—Reinhardt Thiessen, Ph.D., of the Bureau of Mines (U.S. Department of the Interior), "The Microstructure of Coal."

Dates to be hereafter announced :—

C. F. Elwell, B.A., "Progress in the Radio Art : A Survey of Accomplishment and Possibilities of Future Development."

James Paterson (of Messrs. Carter Paterson & Co., Ltd.), "Horse Traction and Motor Traction."

Sir James Alfred Ewing, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., Principal and Vice-Chancellor, Edinburgh University. (William Sturgeon Lecture under the Dr. Mann Trust.)

Sir Frank Baines, C.V.O., C.B.E., "Preservation of Folk Architecture in this Country."

Indian Section.

Friday afternoons, at 4.30 o'clock.

January 22.—Colonel W. M. Coldstream, R.E., C.I.E., "Indian Maps and Surveys." Sir John O. Miller, K.C.S.I., in the Chair.

February 19.—Sir Michael F. O'Dwyer, G.C.I.E., K.C.S.I., "Religions and Races in the Punjab." (Sir George Birdwood Memorial Lecture.) The Right Hon. the Earl of Ronaldshay, G.C.S.I., G.C.I.E., late Governor of Bengal, in the Chair.

MARCH 19, APRIL 16, MAY 14.

Dates to be hereafter announced :—

LADY CHATTERJEE, " Women and Children in Indian Industries."

HERBERT BAKER, A.R.A., F.R.I.B.A., " The New Delhi."

JOSEPH CHARLES FRENCH, I.C.S., " Buddhistic Art in Bengal."

RALPH SNEYD PEARSON, C.I.E., F.L.S., " Indian Forest Products."

DOMINIONS AND COLONIES SECTION.

March 4, May 6.

INDIAN AND DOMINIONS AND COLONIES SECTIONS (JOINT MEETING.)

SIR RICHARD REDMAYNE, K.C.B., M.I.M.E., F.G.S., " The Work of the Imperial Institute."

CANTOR LECTURES.

Monday evenings at 8 o'clock.

H. P. SHAPLAND, A.R.I.B.A., Editor of the *Cabinetmaker*, " The Decoration of Furniture." Three Lectures. January 18, 25 and February 1.

LECTURE I.—Moulding. Geometric pattern formed by mitreing of mouldings. Invention of waved mouldings. Enriched mouldings in wood and metal. Piercing. Gothic Motifs in early Furniture. Elaborate piercing in 18th Century work. Turning. Split turning applied as surface decoration. Turned bosses used cabochon-wise. Twisting or spiral turning. The double twist. Carving.

LECTURE II.—Veneering. Popular misconceptions as to the process. Saw cut and knife cut veneers. Oystershell veneers. Crossbanding and stringing, Inlaid work. Marqueterie, Black and White effects. Relief Intarsia. Portraiture. Certosina work. Dutch Marqueterie. Gilding. Description of the process. Oil gilding and water gilding. German gilt work. Painting and graining.

LECTURE III.—Lacquering. Preparation of the gum method of application. Damp presses for drying. Prolonged treatment of fine lacquer. European lacquer. The decoration of furniture by the application of leather, needlework, velvet and other textiles. Overlaying with ivory, precious metals and tortoiseshell. The enrichment of Cypress chests. Gesso work. Composition ornament. Sevres and Wedgwood plaques.

G. W. C. KAYE, O.B.E., D.Sc., Superintendent, Physics Department, National Physical Laboratory, " The Production and Measurement of High Vacua." Three Lectures. February 15, 22, and March 1.

W. F. HIGGINS, National Physical Laboratory, " Thermometry." Two Lectures.

CHARLES REED PEERS, C.B.E., M.A., Director S.A., Chief Inspector of Ancient Monuments, H.M. Office of Works, " Ornament in Britain." Three Lectures. April 19, 26, and May 3.

LECTURE I.—Definitions. The value and intention of ornament. Prehistoric ornament. Bronze Age. Hallstatt and La Tène. Classic and barbarian art. Lines of communication. Trade and invasion. The Roman conquests. Late-Celtic Art.

LECTURE II.—Roman Britain. The northern invaders. The Christian Mission. Iona and Northumbria. Benedict Biscop and Wilfrid. Offa of Mercia. Alcuin and Charlemagne. The classic revival. The Danes. The Norsemen. Alfred. Athewold and the school of Winchester.

LECTURE III.—Edward the Confessor and the Normans. The Norman Conquest. English Romanesque. The evolution of Gothic art and its use of ornament. The high-water mark. The decline.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 11..Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Mr. W. C. Clinton, "The Electrical Installation in the Rockfeller Building, University College": at Messrs. Sopwith's Lounge, Northumberland Street, Newcastle-on-Tyne. 7. p.m. Mr. L. E. Mold, and Mr. A G. Shearer, "Switchgear for Large Power Stations." At Swansea, Mr. R. A. Chattock. Presidential Address.

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Mr. J. P. Mills, "The Assam-Burma Frontier."

Mechanical Engineers, Institution of, Storey's Gate, St. James's Park, S.W. 7 p.m. Mr. E. H. Lewis, "The Reduction of Factory Costs."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Prof. F. C Thompson, "The Mechanical Properties of Non-Ferrous Metals and Alloys at High Temperatures."

Selborne Society, at Civil Service Commission, Burlington Gardens, W. 6.30 p.m. Lt.-Col. J. Atkinson, "Humour in the Law." Mr. Patrick Braybrooke, "Bernard Shaw." Mrs. H. Daman, "A Glimpse of Canada."

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. W. L. Taylor, "Recent Forestry Development:"

Victoria Institute, Central Hall, Westminster, S.W. 4.30 p.m. Prof. Theophilus G. Pinches, "Notes on the Discoveries at Ur and Tel Al-Obeid, and the Worship of the Moon-God."

Brewing, Institute of, at the Engineers' club, 39 Coventry St., W.C. 7.45 p.m. Mr. James Stewart, "Malting Barleys of 1925."

TUESDAY, JANUARY 12..Aeronautical Engineers, Institution of, at 39, Victoria Street, S.W. 6.30 p.m. Mr. C. Howarth, "Some Aspects of Full Scale Experiments."

Colonial Institute, at Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Sir C. A. Harris, "From Terra Firma to Terra Nova. Points on the track of the Old Navigators."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. Cyril F. Bengough, "High-Level Bridge, Newcastle; underpinning and repair of Foundations of River Piers."

Electrical Engineers, Institution of, at the Hotel. Metropole, Leeds. 7 p.m. Mr. W. E. Burnand, Inventions and Patents.

At the North British Station Hotel, Edinburgh. 7 p.m. Mr. H. M. Sayers, "Electricity Supply Tariffs."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. Stanley E. Bowrey, "Lubrication."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. A. Swan Watson, "The Influence of the Renaissance on Italian Painting."

Petroleum Technologists, Institution of, at the Royal Society of Arts, John Street Adelphi, W.C. 5.30 p.m. Mr. J. Stanley Lewis, B.Sc., A.I.C., "The Vapour Pressures of Fuel Mixtures, Part II." Professor J. S. S. Brame, "The Estimate of Unsaturated and Aromatic Hydrocarbons."

WEDNESDAY, JANUARY 13..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. F. J. Paice, "The Testing and Examination of Materials for Railway Construction."

Electrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Mr. C. E. Webb, "The Power Losses in Magnetic Sheet Material at High Flux Densities."

Structural Engineers, Institution of, at Manchester. Prof. J. Husband, "The Lateral and Transverse Bracing of Bridges."

United Service Institution, Whitehall, S.W. 3 p.m. Major-General Sir J. S. Fowler, "The Chinese Armies of the Present Day."

THURSDAY, JANUARY 14..Electrical Engineers, Institution of, at University College, Dundee. 7.30 p.m. Mr. W. M. Mackay, "Atmospheric Electricity."

Historical Society, 22, Russell Square, W.C. 5 p.m. Prof. F. M. Stenton, "The Foundations of English History."

Mechanical Engineers, Institution of, at 9, The Temple, Dale Street, Liverpool. 7.30 p.m. Mr. S. B. Freeman, "Third Report of the Marine Oil Engine Trials Committee."

At South Wales Institute of Engineers, Cardiff. 6 p.m. Major S. J. Thompson, "Co-partnership in Industry."

Optical Society, at Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.

Oil and Colour Chemists' Association, at 8, St. Martins' Place, W.C. Mr. A. E. Lain, "Cellulose Nitrate Lacquers." Mr. A. W. Lattey, "Leather Japanning.

Royal Society, Burlington House, Piccadilly, W. 4.30 p.m.

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Mr. H. Avray Tipping, "English Furniture under the Stuarts."

FRIDAY, JANUARY 15..Engineering Inspection, Institution of, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Messrs. B. P. Dudding and G. T. Winch, "The Characteristics of Electric Lamps in Relation to their Testing."

Junior Engineers, Institution of, 39, Victoria Street, S.W. 7.30 p.m. Mr. J. Wolstenholme, "Modern Foundry Practice."

London Society, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 4.30 p.m. Miss L. G. Crum, "The Banks of London River."

Mechanical Engineers, Institution of, Storey's Gate, St. James's Park, S.W. 7 p.m. Discussion on "Novelties at the 1925 Engineering Exhibitions."

Medical Officers of Health, Society of, 1, Upper Montague Street, W.C. 5 p.m. Dr. C. Edward Wallis, "Dental Defects and Public Health."

Mechanical Engineers, Institution of, at Philosophical Hall, Park Row, Leeds. 7.30 p.m. Prof. F. C. Lea, "Repetition Stresses."

Metals, Institute of, at University College, Swansea 7.15 p.m. Prof. F. C. Thompson, "The Wire-Drawing Process."

At the University, St. George's Square, Sheffield. 7.30 p.m.

Structural Engineers, Institution of, at Birmingham. Mr. W. E. Ballard, "Metallisation with special reference to Zinc Coatings to prevent corrosion of Structural Steelwork."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Messrs. A. C. Banfield and J. Dudley Johnston, "Thiocarbamide Lantern Slide Making."

JOURNAL OF THE ROYAL SOCIETY OF ARTS, JANUARY 15, 1926.

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3817 VOL. LXXIV.

FRIDAY, JANUARY 15th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 18th, at 8 p.m. (Cantor Lecture.) H. P. SHAPLAND, A.R.I.B.A., Editor of the *Cabinetmaker*, "The Decoration of Furniture." (Lecture I.)

WEDNESDAY, JANUARY 20th, at 8 p.m. (Ordinary Meeting.) H. HOULSTON MORGAN, Ph.D., B.Sc., F.C.S., President, Oil and Colour Chemists' Association, "Problems in Paint and Varnish Technology." SIR FRANK BAINES, C.V.O., C.B.E., will preside.

FRIDAY, JANUARY 22nd, at 4.30 p.m. (Indian Section.) COLONEL W. M. COLDSTREAM, R.E., C.I.E., "Indian Maps and Surveys." Sir John O. MILLER, K.C.S.I., LL.D., will preside.

DOMINIONS AND COLONIES SECTION.

TUESDAY, JANUARY 5th, 1926. THE RIGHT HON. SIR FREDERICK LUGARD, G.C.M.G., C.B., D.S.O., Commandeur de la Légion d'Honneur, late Governor-General of Nigeria, in the Chair. A paper entitled "France in North Africa," was read by HENRY D. DAVRAY, C.B.E., Chevalier de la Légion d'Honneur, late correspondent of the *Daily Telegraph* in North Africa.

The paper will be published in the *Journal* of February 5th.

DR. MANN JUVENILE LECTURE.

Under the Dr. Mann Trust PROFESSOR HENRY E. ARMSTRONG, F.R.S., on Wednesday afternoon, January 6th, presented to a juvenile audience the first act of a performance entitled "Alice in Wonderland at the Breakfast Table."

The main idea underlying the presentation was to set young people thinking about the various kinds of food which they eat—what they are made of, why they eat them, and what are their effects. Alice (Miss Florence Hermes),

who made her appearance through a looking glass, found the Duchess (Mrs. H. L. Armstrong), the March Hare (Master Keith Buchanan), the Dormouse (Miss Frances Lilian Armstrong), the Mad Hatter (Master Lawrence Mackenzie Miall), and Brer Rabbit (Master Kenneth Evans), seated at a breakfast table with the Cook in attendance; at their invitation she joined them, and they proceeded to discuss in Wonderland fashion such common objects of the breakfast table as sugar, salt, and sausages, as well as cabbages, beetroots, and in general such questions as

"Why the sea is boiling hot
And whether pigs have wings."

They did, in fact, carry out on the stage an experimental enquiry as to why ice cream freezes at 32° Fahrenheit and at 0° centigrade—which suggested the further question why we should be bothered with two different thermometric systems. Why not in fact introduce the decimal system all round and have a day of 10 hours instead of 12, which might have the incidental advantage of making a working day of 7 hours or even less acceptable to everybody?

Professor Armstrong, in a doctor's gown and a couple of hoods, presided over the company in the character of an academic Father Christmas—a part which he explained had been offered to Sir Oliver Lodge and declined by him with contumely. The other parts were played by young friends of Father Christmas, and with great success, nothwithstanding the fact that measles, chicken pox and tonsillitis had played havoc with the original cast and had made rehearsals almost impossible.

BINDING COVERS FOR JOURNALS.

For the convenience of Fellows and others wishing to bind their annual volumes of the *Journal*, cloth covers can be supplied, post free, for 2s. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

COAL ASH AND CLEAN COAL.

By R. LESSING, Ph.D., M.I.Chem.E.

LECTURE I.—*Delivered November 23rd*, 1925.

INTRODUCTION.

It is with a certain feeling of apprehension that I venture to introduce to you a subject dealing with so worthless a material as coal ash. Moreover, in anticipation of any reproaches of false pretences, I have to make

the confession that the part of these lectures dealing with the second half of the title, clean coal, will—alas—require only a small fraction of the allotted time for a complete exposition of the existing knowledge concerning it. Nevertheless, I hope to convince you that the valueless impurities in coal, as we know it, deserve a closer attention than they have received in the past, and that their study is indissolubly bound up with the investigation of the true coal substance and, indeed, with the great coal problem itself, on which our present system of civilisation is based.

THE ECONOMIC SIGNIFICANCE OF THE MINERAL CONSTITUENTS OF COAL.

To realise the bearing which the mineral constituents of coal have on the economics of the fuel requirements of Great Britain, it might be useful to give one striking example.

In the absence of reliable statistics it is safe to take the mean percentage of ash in coal put on the market to be 10%. If we assume the annual coal production in Great Britain to be 250,000,000 tons, we find that upon burning the coal or the coke made from it, 25,000,000 tons of incombustible material are obtained. The average length of haul of coal by railway companies (exclusive of private lines) is about 43 miles and with a freight rate of slightly more than one penny per ton-mile, the average railway receipt for the last period for which returns are available (March, 1925), works out at 3s. 8d. per ton. We are, therefore, spending approximately £4,500,000 per annum on material which is worse than useless, since probably more than double this amount is expended in the collection and disposal of the ashes from the place of consumption to their final resting place. The consequential losses from lowering the combustion and carbonising efficiencies can hardly be estimated with any degree of accuracy, but they again will be a multiple of the figure quoted. The Country's non-productive expenditure on this score may therefore, be safely put at the stupendous figure of from £10-20,000,000, a waste which surely should be a worthy subject of the closest scientific, technical and economic examination.

INFLUENCE OF INORGANIC COMPOUNDS ON THE FORMATION OF COAL.

To comprehend the full significance of the mineral constituents and companions of coal, the manner and conditions of its formation should be constantly kept in mind. This problem, on account of the multitude and variety of factors governing the incidence and the properties of coal desposits seems almost incapable of a complete solution and a good deal of the geological, petrographical, botanical, physical and chemical evidence on its different phases remains inconclusive.

It cannot be my task to enter into a discussion of the many hypotheses advanced to explain all or any of these phases. It may suffice to recall that ordinary coal is a compact, stratified mass of the remains of plants, which

have undergone partial decay varying in character and arrested at different stages. With the exception of cannels, in the accretion of which the micro-organisms of plankton and marine fauna played a part, the practically exclusive vegetable origin of coal requires no further proof.

The principal differences between various kinds of coal are due, (1) to the kind of vegetable raw material from which they were formed, (2) the conditions under which this material was accumulated, (3) the agencies by which it was decayed, and finally (4) the stage at which these biological, chemical and physical processes came to a standstill or—more strictly speaking and recognising the never-ceasing activities of nature—the stage at which these changes have arrived in our geological era.

The plant material may have varied from tree trunks down to fragments of twigs, leaves, spores, pollen, algae and micro-organisms of any kind that formed the forests, swamps and other vegetation of the palaeozoic, or in the case of younger coals, of later periods.

The accumulation of these vegetable masses has varied locally according to their deposition in sea water, brackish water, fresh water or on land.

The resultant products of decay, apart from the material from which they are derived, and its environment, are dependent on the kind of change it has undergone; this may have been bacterial, enzymatic or purely chemical, and subject to aerobic or anaerobic, oxidising or reducing conditions, and to climatic and other physical factors, such as heat and pressure.

These four groups of factors, involved in determining the formation, structure and constitution of coal, are each and all influenced by the nature of the inorganic compounds with which the organic material is associated or in contact.

Inorganic Plant Constituents.

In the first place must be mentioned the inorganic constituents of the plant substance, although as will be seen later, this source is quantitatively the least important. The consideration of that portion of coal "ash," contributed by the plant itself, involves a study of plant physiology and particularly plant metabolism, a subject the vastness and complexity of which does not permit of giving it here more than the most casual attention. A more detailed examination of the relation of plant ash to the inorganic constituents of coal has recently been made by P. Haas (1), from which the intricacies attaching to the study of the ash even of present-day plants become manifest. The difficulties of interpreting the experimental results obtained from the examination of fossil coal are enhanced by the fact that we are dealing with a vegetation concerning the composition of which we can only speculate from analogy with modern plants and a vegetation the conversion of which into coal must have also affected its inorganic compounds.

(1) "Fuel in Science and Practice," 1925, 4, 424.

The number of "essential elements" (other than carbon, hydrogen, oxygen and nitrogen) invariably occurring in plant ashes, viz., iron, calcium, magnesium, potassium, sulphur and phosphorus, provide by their varying proportions and total content a wide range of combinations which are added to by other elements such as silicon, aluminium, manganese, sodium, chlorine and iodine, which are "non-essential," but may persistently occur in some plants.

Complications arise from the differences in the ash content and composition of different kinds of plants, and different parts of a given plant; thus the ash may vary from a fraction of 1 per cent. in the wood to 20 per cent. or more in the leaves, the living tissues being always higher in ash than the non-living.

Further differences are introduced by seasonal and even diurnal variations, by the nature of the soil on which the plant grows, its age, the effect of salts in water in the case of aquatic and marine plants, of sunlight or shade and many other factors, difficult enough to elucidate by experiments with modern plants, but almost too complex to unravel from the mixture of vegetation decayed and transformed into what we know as coal.

And yet, I am convinced that the inorganic constituents of individual plant entities will form a useful guide in work on the constitution of coal, once methods are worked out for correlating them with the results from the analysis of the organic portion and the findings of microscopic examination.

A comparison of the ash from groups of coal components with the ash from lycopodia has already proved useful (2) if only as negative evidence. For the inference that the high aluminium content of durain (dull coal) might be due to its derivation from lycopods could be disproved by establishing the alumina-silica ratio as shown in Table I.

TABLE I.

	Percentage in ash.		
	Al_2O_3.	SiO_2.	$\frac{Al_2O_3}{SiO_2}$.
L. chamaecypar. with spores (Aderholt)	51.85	13.60	3.81
,, without spores (Aderholt) ..	57.36	12.96	4.43
L. clavatum (Aderholt)	26.65	13.94	1.91
,, (Ritthausen)	39.07	18.82	2.11
,, ,, ...	22.20	13.01	1.71
,, (Church)	15.24	6.40	2.38
L. complanatum (Ritthausen)	37.87	10.06	3.76
L. alpinum (Church)	33.50	10.24	3.27
L. selago (Church)	7.29	2.53	2.88
Average ratio			2.92
"Mineral Charcoal"—			
"Better Bed" (Thorpe)	33.8	38.7	0.87
"Haigh Moor" (Thorpe)	28.7	36.1	0.80

(2) Lessing, Trans. Chem. Soc., 1920, *118*, 264.

Fusain (Lessing)	8.66	8.84	0.98
Durain ,, ...	42.34	50.54	0.84
Clarain ,, ...	16.58	9.44	1.76
Vitrain ,, ...	15.49	6.08	2.55
Kaolinite (calcined) (Theory)	45.87	54.13	0.85

The results show that durain ash is identical with clay whilst clarain and vitrain closely resemble plant ashes.

INORGANIC COMPOUNDS IN THE ACCUMULATION OF COAL-FORMING MATERIAL.

The accretion of the vegetable mass is subject to the influence of the conditions of accumulation. Material carried by, or laid down in salt or brackish water covers itself with a salt solution which after subsequent processes of evaporation or drying, leaves films of these salts upon the surface of the plant fragments. Even if a subsequent leaching-out of soluble salts with fresh water should take place, some of these will be retained by adsorption. Since the plant fragments are largely composed of colloidal substances, the electrolytes introduced with sea water cause coagulation to take place, which again tends to lock up the dissolved salts of the reacting solutions.

These phenomena must be regarded as one of the sources of the sodium chloride content of many coals which in practice shows itself as a destructive constituent, when, as in coke ovens or gas retorts, it is volatilised and attacks, as a fluxing agent, the refractory materials of which they are built.

Sodium chloride is, of course, not the only soluble salt which may thus be incorporated into the mass of coal-forming material, but the minor constituents of sea water play their part according to the laws of physical chemistry. For instance, the magnesium content of the dolomitic concretions known as "coal balls," must be ascribed to the magnesium chloride from sea water.(3).

The admixture of inorganic substances to the coal forming magma is by no means restricted to soluble salts. The water with which the plant material came into contact had in many cases mineral detritus, mostly in form of mud suspended in it. This mud became intermingled with the vegetable mass or settled on it. Where it was finely sub-divided or in form of colloidal solutions, it percolated the magma with comparative ease to be deposited by gravity or by coagulation where the chemical conditions permitted.

Whilst contact with saline solutions or mud suspensions thus caused the deposition of inorganic substances, percolating water in other cases has brought about a leaching-out of the soluble plant salts and the minerals contained in the deposit. An important and as yet unexplained phenomenon is the difference between the total ash content of modern plants and the inherent ash of a large portion of most bituminous coals.

As in the adsorption or other retention of salts by the peat or coal magma, so in the removal therefrom of soluble salts, colloidal phenomena play an important

(3) Stopes and Watson, Phil. Trans., 1908, B.200, 167.

part. This is particularly the case where, by the decay of the vegetable debris, soluble organic compounds of an acid character, such as ulmic acid, are formed; solutions containing these, on percolating through lower layers leach out bases which are reprecipitated on continuing their downward path. In this manner a redistribution of certain inorganic compounds, notably iron and alumina, takes place, somewhat on the lines of the formation of hardpan, known to the agriculturist and forester.

In many respects the problems involved resemble those dealt with by the soil chemist, who is concerned with the first member of the chain leading from vegetable debris through peat, lignite and brown coal to bituminous coal and finally anthracite.

In the various theories evolved on the mode of decay of the raw material of coal and its degradation into a compact highly carbonaceous fuel, the function of the inorganic accessories has not yet been made the subject of close investigation. Whether the processes of coal formation were biological or chemical, it must from analogies in fermentation practice and from experience with catalysts be expected that the mineral ingredients had a very decided influence on the course of decomposition of the organic matter. The theory of Fischer and Schrader which postulates the disappearance of cellulose by biological agencies and the formation of coal from the lignin residue, although not generally accepted in its entirety, may serve as an example, and in regard to it the observation of Hoppe-Seyler (4) becomes significant that in the fermentation of cellulose, the reduction of calcium sulphate, the formation of ferrous carbonate and sulphide, and other reactions with inorganic compounds are closely connected with the degradation of the organic matter.

Mineral Matter in Coal after its Formation.

The diversity of material and conditions involved in the formation of coal explains the differences in the structure, composition and general properties of the world's coal deposits, and of different parts of a given seam. The fact that different portions of the same lump of coal contain different amounts of mineral matter was pointed out as early as 1848 by de Marsilly (5) who stated "however pure a piece of coal may be and however homogeneous it may appear to the eye, its different parts do not yield the same proportions of fixed residue on incineration." There were, however, until recently, comparatively few analyses on record, of the ash of clearly defined constituents of coal, such as the composition of the ash of "mineral charcoal" (fusain) from Better Bed and Haigh Moor reported by Thorpe.(6).

(4) Ber. 1883, *16*, 122; Z. Physiol Chem., 1886, *10*, 201, 401.

(5) Compt. rend., 1848, *46*, 882.

(6) Greene, Miall, Thorpe, Rücker and Marshall, "Coal, its History and Uses," 1878, 167.

The separation by Stopes of four distinct ingredients from bituminous coal made it possible to enquire more closely into their mineral constituents. These coal components are: *fusain*, the equivalent of "mother-of-coal" or "mineral charcoal;" *durain*, the dull hard coal; *clarain*, the portion of bright coal still containing plant debris; and *vitrain*, the bright coal of conchoidal fracture, originally thought to be without structure but now known to have a definite though largely obliterated structure. By the work of Stopes, Tideswell and Wheeler, Lessing and a number of subsequent workers, the differences in the microstructure of these coal components were proved to be associated with characteristic differences in their chemical composition and properties, and notably in their behaviour on extraction with solvents, thermal decomposition, oxidation and hydrogenation.

In particular it was shown (7) that the four groups of ingredients varied in the amount and composition of their ash in a remarkable manner.

The ash percentages obtained from the first coal examined, the Thick Seam of Hamstead, South Staffs., were as follows:—

	Ash per cent.
Fusain	15.59
Durain	6.26
Clarain	1.22
Vitrain	1.11

The four ashes showed considerable differences in colour and mechanical structure. That from fusain was dark brownish-grey; that from durain pure pale grey or almost white without the slightest brown tint; that from clarain a reddish-brown biscuit, and that from vitrain a pale biscuit colour. On burning large lumps, lamination is produced along the bedding planes of the coal. Clarain ash invariably contains intrusions of grey plates indicating the presence of durain or possibly fusain, whilst vitrain also contains occasionally grey laminae and red ferruginuous specks. Fusain and durain ash are always in form of a dense powder, whilst clarain and vitrain yield a light and unmistakably fluffy ash; its gossamer-like structure represents the skeleton of materials consisting to the extent of nearly 99% of combustible matter. These characteristics have been confirmed in the examination of so many coals that they must be regarded as typical for the four components and that the mere appearance of the ashes may form a useful and definite guide for their identification, with the qualification that differentiation between clarain and vitrain is not always quite easy on account of their close similarity.

The differences indicated by the appearance of the ashes are confirmed by their chemical composition as recorded in Table II.

(7) Lessing, Trans. Chem. Soc., 1920, *117*, 256.

TABLE II.

Fusain.

	Soluble in water. Per cent.	Soluble in HCl. Per cent.	Insoluble in HCl. Per cent.	Total. Per cent.
SiO_2	Nil	0.78	8.06	8.84
Al_2O_3	0.19	8.33	4.06	8.66
Fe_2O_3				3.37
MnO				0.51
TiO_2				0.04
CaO	10.03	46.64	0.33	57.00
MgO	0.41	0.89	Nil	1.30
Na_2O	0.65	2.59	—	3.24
K_2O	0.14	0.53	—	0.67
SO_3	4.71	9.17	0.77	14.65
P_2O_5	—	—	—	—
CO_2	0.53	2.45 (diff.)	—	2.98
Total	16.66	71.38	13.22	101.26
Total by direct weighing	16.57	71.38	12.05	100.00

Durain.

	Soluble in water. Per cent.	Soluble in HCl. Per cent.	Insoluble in HCl. Per cent.	Total. Per cent.
SiO_2	Trace	1.46	49.08	50.54
Al_2O_3	Trace	19.94	24.20	42.34
Fe_2O_3				1.36
MnO				Nil
TiO_2				0.44
CaO	1.47	1.85	0.37	3.69
MgO	Nil	Nil	Nil	Nil
Na_2O	Nil	Nil	Nil	Nil
K_2O	Nil	Nil	Nil	Nil
SO_3	2.10	0.98	0.15	3.23
P_2O_5	—	—	—	—
Total	3.57	24.23	73.80	101.60
Total by direct weighing	3.48	23.81	72.71	100.00

The high percentages of water-soluble and the low hydrochloric acid insoluble in the ashes from clarain and vitrain prove that they represent the original plant ash. The ash of durain, three-quarters of which is insoluble in hydrochloric acid, has been already shown by its alumina : silica ratio to consist in the main of clay- substance, whilst a moderate amount of water-soluble and acid-insoluble and a good deal of acid-soluble in the ash from fusain indicates its derivation from the carbonates or other salts of infiltered water, retained by this highly absorptive substance.

Clarain.

	Soluble in water. Per cent.	Soluble in HCl. Per cent.	Insoluble in HCl. Per cent.	Total. Per cent.
SiO_2	0.12	0.96	8.36	9.44
Al_2O_3	0.10	12.66	7.86	16.58
Fe_2O_3				3.31
MnO				0.23
TiO_2				0.50
CaO	10.50	1.94	0.54	12.98
MgO	9.20	1.32	Nil	10.52
Na_2O	13.76	1.95	—	15.71
K_2O	Nil	Nil	—	—
SO_3	31.73	0.45	—	32.18
P_2O_5	Nil	0.01	Nil	0.01
Total	65.41	19.29	16.76	101.46
Total by direct weighing	65.24	17.86	16.90	100.00

Vitrain.

	Soluble in water. Per cent.	Soluble in HCl. Per cent.	Insoluble in HCl. Per cent.	Total. Per cent.
SiO_2	Trace	0.76	5.32	6.08
Al_2O_3	3.11	13.44	2.40	15.49
Fe_2O_3				3.09
MnO				0.13
TiO_2				0.24
CaO	12.42	2.46	0.34	15.22
MgO	1.04	0.83	Nil	1.87
Na_2O	16.12	1.55	—	17.67
K_2O	0.20	Nil	—	0.20
SO_3	28.62	1.49	0.78	30.89
P_2O_5	—	—	—	Trace
CO_2	6.69	—	—	6.69
Total	68.20	20.53	8.84	97.57
Total by direct weighing	69.52	20.46	10.02	100.00

It must, of course, be remembered that both durain and fusain also contain their own quota of residual plant ash, and that fusain, clarain and vitrain ashes comprise a certain amount of suspensoids of a clay character such as constitutes the bulk of the ash of durain.

In employing the sub-division of coal into components as proposed by Stopes and the corresponding nomenclature and methods of identification, it must be mentioned that these have not remained unchallenged. R. Thiessen (8), as a result of purely microscopical examination, recognises only three

(8) White and Thiessen, U.S. Bureau of Mines, Bull. 38, 1913.

components, viz., fusain, "attritus" and "anthraxylon"; whilst W. A. Bone (9) recently expressed his preference for describing as "dull coal" and "bright coal" the components other than fusain.

It has recently been found that by substituting examination of polished coal surfaces in reflected light, a method originally proposed by H. Winter (10) in Germany and brilliantly applied by C. A. Seyler (11) and by Miss M. Evans in this country, morphological structure can be discerned in vitrain which in thin sections observed by transmitted light had been found by Stopes to be a structureless gel. Figs. 1 and 2 are examples of microphotographs of coal surfaces in reflected light, prepared by C. A. Seyler. Fig. 1 shows intercellular

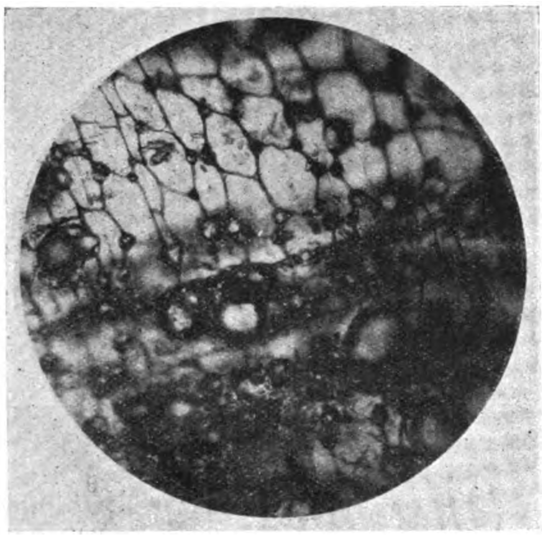

FIG. 1 (×450). Microphotograph in Reflected Light (Seyler).

spaces filled with pyrites. Fig. 2 shows nodules of arsenical pyrites in anthracite. It has, therefore, become necessary to review the position, to define or circumscribe the various components or groups of compounds and to bring the contending nomenclatures into harmony. Pending arrival at a general agreement on these points, it should be remembered that the classification of Thiessen rests on a botanical and that of Stopes on a petrological basis, *i.e.*, Thiessen defines his groups of substances by their origin, and Stopes by their present physical appearance and chemical properties.

I venture to suggest that the ash constituents will be found as useful an index of the component parts of a coal seam as type-fossils are in the identification of geological strata. Indeed, their significance should not be overlooked

(9) J. Soc. Chem. Ind., 1925, *44*, 291T.

(10) Fuel, 1923, *2*, 78.

(11) Fuel, 1923, *2*, 217; 1925, *4*, 56.

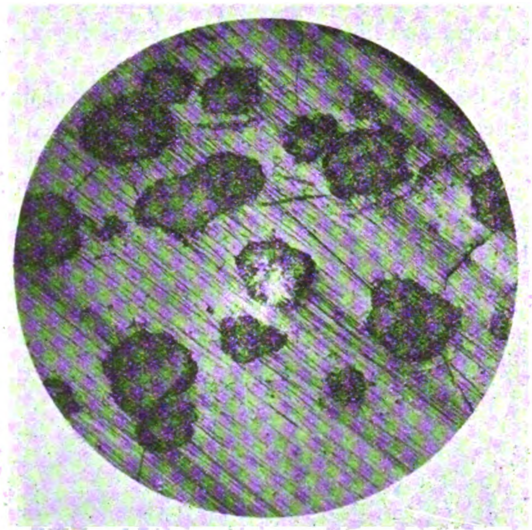

FIG. 2 (×100). Microphotograph in Reflected Light (Seyler).

in any system of coal classification, whether for scientific or commercial purposes.

DISTRIBUTION OF MINERAL MATTER IN COAL.

The analytical material available enables us, even at this juncture, to correlate with a great measure of confidence the ash-forming substances with the actual coal components and to determine the general distribution of mineral matter in bituminous coal During recent years a number of coals have been investigated by others (12) along the lines I adopted originally, and many have been examined in great detail in my laboratory. Further, the variation of ash percentages and composition in particles of different size from the same component of a given coal has been studied (13).

The contents of Table III. may be quoted as a typical example :—

The table shows that the ash content of clarain-vitrain decreases down to the smallest size, which on account of an addition of fusain and shale dust is somewhat higher. Durain ash is practically independent of size, no doubt due to the homogeneity of the admixture of clay to the coal substance. The dirt portion increases in ash towards the smaller sizes, due to the concentration of the more friable minerals in them.

(12) Grounds, J. Soc. Chem. Ind., 1922, *41*, 88T; Baranov and Francis, Fuel, 1922, *1*, 219.

(13) Lessing, Trans. Inst. Min. Eng., 1921, *60*, 228; *61*, 36; 1923, *64*, 296.

TABLE III.

ASH IN GRADED FRACTIONS CONTAINED IN LUMP-COAL FROM THE THICK SEAM HAMSTEAD COLLIERY.

Screen.	Grading test.	Dust.	Clarain-Vitrain	Durain.	Dirt.
FRACTIONS: PERCENTAGE ON ENTIRE SAMPLE.					
On 5	5.70	Trace	4.81	0.85	0.04
Through 5 on 10 ..	63.70	Trace	41.84	21.64	0.22
,, 10 on 20 ..	12.90	0.05	7.96	4.84	0.05
,, 20 on 30 ..	6.50	0.03	4.07	2.35	0.05
,, 30 ..	11.00	3.75	4.88	2.27	0.10
Loss on sifting ..	0.20	—	—	—	—
	100.00	3.83	63.56	31.95	0.46
ASH: PERCENTAGE ON FRACTIONS.					
On 5		—	2.28	5.74	29.64
Through 5 on 10 ..		—	1.85	4.62	30.57
,, 10 on 20 ..		—	1.30	4.26	46.02
,, 20 on 30 ..		—	1.25	4.45	50.42
,, 30		2.98	1.90	5.58	63.19
ASH: PERCENTAGE ON ENTIRE SAMPLE.					
On 5	0.17	—	0.11	0.05	0.01
Through 5 on 10 ..	1.84	—	0.77	1.00	0.07
,, 10 on 20 ..	0.33	—	0.10	0.21	0.02
,, 20 on 30 ..	0.17	—	0.05	0.10	0.02
,, 30	0.39	0.11	0.09	0.13	0.06
	2.90	0.11	1.12	1.49	0.18

The results from the examination of many coals on similar lines and the complete analysis of the ash of their various fractions broadly indicate the following distinctions (14):—

1. Clarain and Vitrain contain the inherent plant ash, or what remains of it, from 1.1 to 1.3 per cent., consisting largely of water-soluble and a small percentage of acid-insoluble matter, not strictly belonging to these components.
2. Durain yields about 6-7% of ash, being mostly clay substance.
3. The ash in fusain may vary from 4% to 30% and contains much acid soluble salts ($CaCO_3$, $FeCO_3$), derived from infiltration, together with some clay substance.
4. Cleat and partings have a composition similar to that of fusain.
5. Pyrites and marcasite are distributed in different varieties of crystal form and size.
6. Rock debris from roof, floor and dirt bands of the coal seam accounts quantitatively for the bulk of the ash in commercial coal.

CHEMICAL CHANGES DURING INCINERATION.

We are accustomed to use the term "ash" rather loosely from the chemical point of view. One need hardly stress the point that the inorganic constituents or adventitious impurities are present in coal in a form and combina-

(14) J. Soc. Chem. Ind., 1925, *44*, 277T.

tion different from that in which they eventually exist in the residue from incineration. The results of the analysis of ashes do not, therefore, give a true picture of the composition of the original mineral matter.

The reactions taking place in the conversion of the mineral matter in coal into ash may be of several kinds. There are, firstly, those in which single compounds are involved, such as the dehydration of silicates, the decomposition of calcium carbonate, $CaCO_3 = CaO + CO_2$, or of pyrites, $FeS_2 = FeS + S$, which are accompanied by the loss of volatile compounds; in others the original mineral constituents, such as iron compounds, are oxidised by the air or else reduced by the organic matter. Secondary reactions of decomposition products, such as the reduction of CO_2 to CO, or the formation from sulphur liberated from pyrites, of carbon compounds by interaction with the coal substance, affect the balance between volatile and non-volatile matter. Again, another class of reactions occurs between the residual mineral constituents themselves; their consideration would cover the whole field of the chemistry of silicates and ceramics.

Some of these reactions have a profound influence on the proximate and ultimate composition of coals as ascertained by ordinary routine tests. In arriving at an estimate of the true coal substance in a given coal, allowance should, therefore, be made for the water of hydration, the carbon dioxide in calcium (or iron) carbonate, which according to the temperature employed, may be more or less completely dissociated, the combination of organic sulphur with the lime and alkalies resulting in the formation of sulphates, the partial volatilisation of alkali chlorides or their conversion into carbonates and a number of other reactions for which reliable data are not yet available. Moreover, it must be remembered that the incineration of coal is not a combustion process pure and simple, but that it is preceded or accompanied by non-oxidising thermal decomposition.

Analysis of Ash.

These factors prove that the ordinary methods of estimation of ash, whilst permitting a satisfactory comparison of their amounts, do not give a true picture when the results are used for calculating the pure, ash-free coal substance.

As to ash composition, the testing of commercial well-ground and homogenised samples gives only compound values. A rational analysis of the mineral constituents presupposes a separation of the unburnt coal components on the lines discussed before.

The practice of separating ashes into their water-soluble, acid-soluble and acid-insoluble portions has been found useful (15) inasmuch as it furnishes a guide to the proximate composition of ashes in cases where a complete analysis

(15) As a matter of historical interest, it should be stated that I found subsequently that Vaux (J. Chem. Soc., 1849, *1*, 327) employed a similar subdivision of coal ash.

is not made. It gives at a glance a picture of the character of the ash-forming matter.

PHYSICAL STRUCTURE OF MINERAL CONSTITUENTS.

Even the detailed chemical analysis of individual coal components does not suffice for a complete study of the distribution of the inorganic compounds in coal, and it must be supplemented by methods divulging their physical structure and articulation. This can be done in a simple and very instructive way by incinerating lumps of coal uncrushed instead of the usual powdered mixture, when the ash is obtained in form of a skeleton representing its original orientation in the compact mass of coal. The thin veins of calcite or ankerite in cleat and partings show up in distinct lamination and intrusions of pyrites or shale particles become clearly visible. There is, however, a difficulty in preserving such tender structures for measurement or demonstration.

The microscopical examination of ash skeletons based on observations of F. Schulz was referred to by C. G. Ehrenberg in 1846 (16). In the hands of Molisch (17) it gave beautiful results in the examination of modern plants. According to him, the ash obtained on simple incineration of plant entities or fragments gives frequently a clearer and more comprehensive view of certain morphological conditions; the guiding fragments come out much clearer in the ash than in the tissue itself. The method had been applied to coal particles by von Gümbel (18).

Robert Potonié (19) refers to the pictures obtained as spodograms. Figs. 3 and 4, prepared by E. Stach (20) from a lignite still show, after incineration, the wood structure very clearly.

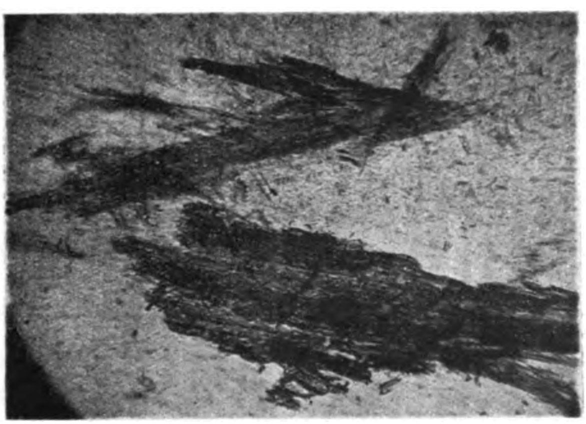

FIG. 3. Microphotograph of Ash (Spodogram) (Stach).

(16) Amer J. Sci. Arts, 1846 (2), *1*, 124 (from: Ann. Mag. Nat. Hist., 1845, *16*, 69).
(17) Sitzgs. Ber. Akad. Wiss., Vienna, 1920, *129*, 261.
(18) Sitzgs. Ber. Bayr. Akad. Wiss., München, 1883, *13*, 111.
(19) Allgemeine Kohlenpetrographie, 1925.
(20) Z. Deutsch, Geol. Ges., 1925, 77, 260.

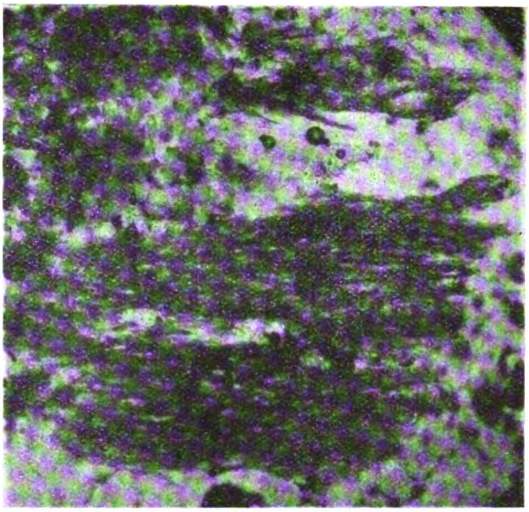

FIG. 4. Microphotograph of Ash (Spodogram) (Stach).

EXAMINATION BY X-RAYS.

The modern development of radiography and its application to general scientific and industrial purposes furnishes a means for studying the mineral matter in coal without any physical or chemical disturbance. Couriot (21) in 1898, only three years after Röntgen's discovery, suggested the use of the rays for the examination of fuels, and added to his paper a number of remarkably good radiographs of different kinds ranging from anthracite to charcoal. He was followed by Daniel in 1899 and by Garrett and Burton in 1912. Iwasaki (22) correlated microscopic and X-ray examination in the study of Japanese coals.

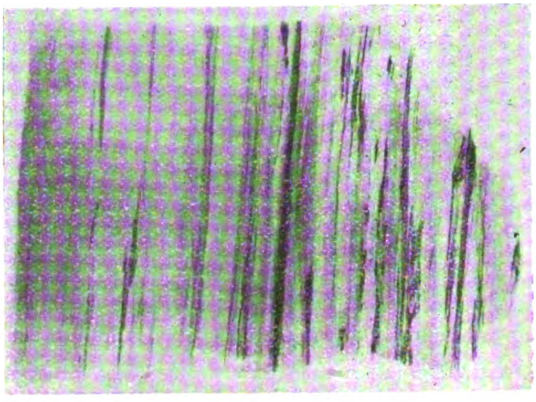

FIG. 5. Scottish Splint Coal ($\frac{1}{2}$ scale).
Radiograph of Lump Coal (Kemp, Thomson and MacLaren).

To Messrs. C. Norman Kemp (23) J. Leslie Thomson and W. MacLaren, belongs the credit of having developed X-ray analysis for the examination of coal in this country, and of having provided an important adjunct to the study of its mineral constituents, made particularly attractive by their stereo-radiographic methods. The distribution of organic matter is clearly seen in fig. 5 (Scottish splint coal) and fig. 6 (Welsh anthracite). Properly correlated with the results from the chemical analysis, the radioscopic and radiographic examination will be found exceedingly helpful in this important branch of coal research.

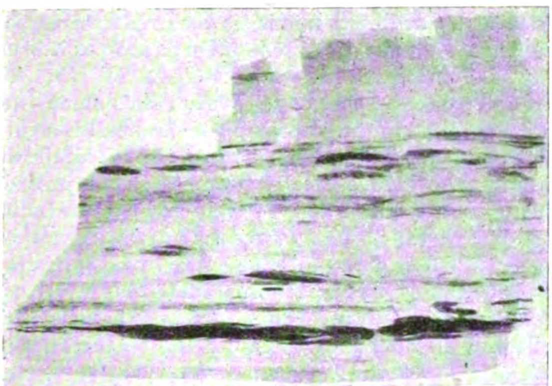

FIG. 6. Welsh Anthracite (½ scale).
Radiograph of Lump Coal (Kemp, Thomson and MacLaren).

(21) Bull Soc. Ind. Min., 1898, 12, 713.
(22) Tohoku Univ. Technol. Rep., 1920, 1, 1; 1922, 2, 235; 1924, 4, 49.
(23) Trans. Inst. Min. Eng., 1924, *67*, 59; J. Soc. Chem. Ind., 1924, *43*, 234T.

NOTES ON BOOKS.

JAMSETJI NUSSERWANJI TATA. A CHRONICLE OF HIS LIFE. By F. R. Harris, New College, Oxford: Oxford University Press, 15*s*. net.

The story of the life of this great Merchant Prince of modern India, Jamsetji Nusserwanji Tata, reminds us of the great figures of the European Renaissance in the 15th and 16th centuries. The outstanding personages of the age of the Medici in Italy and of Elizabeth in England offer the nearest parallel we can think of to this man of modern India, whose vivid and impressionable mind touched life at so many points. His almost childlike enthusiasm for new things and new inventions, his love of travel, his absorbing interest in things intellectual and scientific, no less than his extraordinary creativeness in the practical and material world, are more characteristic of the merchant prince of the European Renaissance than of the modern captain of Industry. Our modern life is too departmentalised. It can show great captains of Industry, great scientists, great artists, great explorers, but has lost the knack of producing men whose full and abounding life combines in one personality something of all these elements. The old Greek definition of happiness "'ενεργέια

κατ' ἀρετην ἐν βίω τελειῳ" would apply fitly enough to the life of Jamsetji Tata.

Mr. Harris gives an excellent account of the launching and amazingly successful development of the Empress Cotton Mills — the great material achievement of Mr. Tata's life—and tells a characteristic story apropos of the establishment of the Mills at Nagpur, a remote and backward town in the Central Provinces, far from the centre of the Cotton Industry at Bombay. The selected site for the Mills adjacent to an old 18th century reservoir, being marshy, required to be levelled and filled in, and a local Nagpur banker, who had been asked to subscribe for shares, refused to take any hand in the schemes of a man "who was throwing his money into a swamp." He lived to regret his mistake and to confess that "Mr. Tata had not thrown gold into the ground but had extracted gold from it." This note of incredulity and lack of confidence in Mr. Tata's schemes, which were too bold and original to be grasped by ordinary minds, is recurrent throughout his life, as is likewise the general anxiety to participate in them as soon as it became evident that they would be unusually successful.

The other great enterprises associated with Mr. Tata's name—the Iron and Steel Company, which has resulted in the conversion of the small Bengal village of Sakchi into the scientifically planned industrial town of Jamshedpur with a population of 80,000 inhabitants, the Hydro-Electric Companies for providing the Mills of Bombay with cheap electric power derived from great dams built on the Western Ghauts (the great dam at Shirawta is larger than the Assouan barrage), and the Institute of Science at Bangalore—all these owe their inception to Mr. Tata's fertile and imaginative genius, but their actual materialisation and development to his sons, Sir Dorabji and the late Sir Ratanji Tata, who piously assumed the responsibility for carrying out all their father's enterprises on the lines he had laid down before his death.

The magnitude of these enterprises and the services rendered by the late Mr. Tata in increasing the material prosperity of India may be indicated by the fact that the combined capital invested in them to-day amounts to nearly £70,000,000.

The Royal Society of Arts has a special interest in the life of Mr. Tata inasmuch as his prolonged search for payable iron ore in India, which was eventually crowned with such complete success, brought him into close touch with Sir Thomas Holland, then Director-General of the Geological Survey of India, and now the Chairman of the Council of the Society. The relations between the two were of the most cordial character, and it is pleasant to read that, at a time when Mr. Tata's plans did not always receive in official quarters the encouragement and support which they deserved, he could always count upon the sympathetic co-operation of the Director-General of the Geological Survey. This connexion between the house of Tata and the Royal Society of Arts is continued by his son, Sir Dorabji Tata, who is a Fellow of the Society at the present time.

In conclusion, we cannot do better than quote the admirable words of Mr. Harris: "Among the present generation of Indians, Jamsetji Tata may seem but a dim recollection, though his life serves well to illustrate the industrial development of his country. His memorials are spread over India, the flourishing town of Jamshedpur, the great Mills at Ahmedabad, Nagpur, and Kurla, the submerged valleys of the Western Ghauts, and the Institute of Science at Bangalore. They remain his noblest monuments, and set an example of achievement to his countrymen."

VICTORIA AND ALBERT MUSEUM. REVIEW OF THE PRINCIPAL ACQUISITIONS DURING THE YEAR 1921, ILLUSTRATED. London: published under the authority of the Board of Education, 1925, 6*s*. net.

VICTORIA AND ALBERT MUSEUM. REVIEW OF THE PRINCIPAL ACQUISITIONS DURING THE YEAR 1922, ILLUSTRATED. London: published under the authority of the Board of Education, 1925. 6s. net.

These two volumes are both of the same admirable quality. They contain lists of donors and bequests for each year, while the bulk of each volume, running to just over 100 quarto pages, is divided into chapters devoted to a critical description, with many illustrations and plates, of the principal acquisitions during the year in each Department of the Museum, i.e., in the Departments of Architecture and Sculpture, Ceramics, Engraving, Illustrations and Design, Paintings, Library, Metalwork, Textiles, Woodwork and the Indian Section. A separate chapter is devoted to loans, and a short annual report is given in an Appendix. The descriptive and critical matter of each chapter is the work of the officers of the various Departments and is excellently done. The illustrations in the text and the plates are first-rate, and convey a lively impression of the artistic beauty of the originals. These publications will be appreciated by all who take an active interest in the various artistic spheres covered by the Museum Departments, and are on the look out to take advantage of opportunities such as these Reviews offer, for adding to their existing knowledge.

PROGRESS OF COTTON GROWING IN ARGENTINA.

The following particulars of the progress of cotton cultivation in Argentina have been furnished by the United States Trade Commissioner at Buenos Aires, as a result of observations made on a journey through all of the principal cotton growing centres of that country:—

Cotton has been grown in Argentina for nearly 300 years, having been cultivated in the missions along the Vermejo River and in the Territory of Misiones. In the past production was for local consumption only. There is no record of any export until the year 1902, when a few bales were shipped to Europe. On a number of occasions during the past 20 years the Argentine Government has sought to encourage the planting of cotton. During the war, however, when prices of American cotton began to rise, an active interest was aroused among the growers in the north of the Republic, and the plantings of cotton were increased. It was not until 1923 that the activity, now apparent among the cotton planters, began as a direct result of the increase in the price of cotton and the persistent reports of expected shortages in the American crop.

In that year the new Argentine Minister of Agriculture initiated a campaign to promote the planting of cotton in the northern regions of the country. The technical bureaus of the Department of Agriculture sent out men to advise the farmers, and also distributed cotton-seed gratis to the small growers. As a result the acreage has been considerably increased.

The "Gran Chaco" is the great centre of Argentine cotton cultivation. It comprises the Territories of El Chaco and Formosa, and parts of the Provinces of Santa Fe, Santiago del Estero, and Salta. The Territory of El Chaco has an area of 52,741 square miles, but its population is only about 1 per square mile. In this district the Government expects to accomplish most in the way of cotton growing. Formosa, just to the north of El Chaco, has 41,402 square miles, parts of which are claimed to be even better adapted for cotton production than El Chaco, but it has no railway connections with Buenos Aires, and is as yet very little developed. It is also known that the part of the Gran Chaco extending into Formosa has very much more low, swampy land than El Chaco itself. Cotton

cultivation is also being carried on in a small way in the Provinçes of Corrientes, Tucuman, Catamarca, Salta, La Rioja, Santiago del Estero, and the Territory of Misiones. Allowing for the available land in all of these Provinces, and adding a part of northern Santa Fe, it is estimated that the cotton district of Argentina will not exceed 165,000 square miles.

The Gran Chaco contains innumerable open-prairie spaces, some of which exceed 50,000 acres in extent. Up to the present time the agricultural plantations have all been located in these prairies, although lumbering and quebracho companies are continually clearing away forests and opening up new spaces. The soil of the Chaco country is very rich and gives high yields of many products. The winters are only two months in length, and are very mild, frost occurring at infrequent intervals.

The yields of cotton obtained in the Chaco country during the past two years have been as high as 500 pounds of ginned cotton per acre, despite the very disorganised methods of cultivation, and the destruction done by locusts. The cotton planters usually reckon on a production of 1 metric ton (2,204.6 pounds) of seed cotton per hectare (1 hectare = 2.47 acres), which is equivalent to about 227 pounds of ginned cotton per acre.

A large number of varieties of cotton have been produced in Argentina, but the type now chiefly grown, known as "chaco" cotton, was originally from Louisiana seed. American cotton experts have been employed to develop a variety best suited for the region, and the Government has laid out a large experimental station in the town of Saenz Peña, where investigations will be conducted.

The cost of cotton production in the Chaco region apparently has been very low. The only trouble experienced by the planters has been the invasion of locusts. The boll weevil has not appeared in the Argentine cotton districts, but the presence of the pink boll worm has been reported. Most of the planters are immigrants whose only implements are those used for ploughing and seeding. The Government has been furnishing them with galvanised iron sheets to protect their fields from the locusts. These sheets or "barreras" are placed along the south side of the fields, and serve to impede the progress of the small locusts while they are moving north during the hopping stage. Trenches are dug outside of the barreras into which the locusts are shovelled and covered over. The National Department of Agriculture claims that it destroyed during this season over 300,000,000 pounds of locusts in the grasshopper stage by these methods.

The size of the majority of the cotton farms is such that the planter with his family and a small amount of occasional help can gather the crop. The number of farms above 100 hectares, however, is increasing, and some of over 400 hectares were visited. On these larger plantations Indian and immigrant labour is employed.

There are 18 gins in El Chaco Territory. These usually purchase the seed cotton outright from the growers, who have little capital, and are obliged to sell at once to meet current expenses. The present methods of operating the gins appear to be rather unsatisfactory, but the cotton experts from the United States are expected to demonstrate more modern and economical means of growing and ginning cotton.

The Argentine Department of Agriculture estimated that 63,000 hectares were planted to cotton last year, but this figure assumed the area under cultivation in the Chaco Territory as 50,000 hectares, which is now considered by the growers to be 20,000 too high. It is probable that a total of 43,000 hectares is more accurate. Calculated on the very conservative basis of a yield of 800 kilos per hectare, the total production would approximate 35,000 metric tons of seed cotton for the entire Republic, or an equivalent of 47,000 bales of ginned cotton.

INDIAN COTTON MILL PRODUCTION.

Information supplied by local millowners to the Department of Statistics, India shows that the total quantity of yarn spun in Indian cotton mills during the month of May, 1924, amounted to 59 million lbs., and that of woven goods to about 35 million lbs., as compared with 52 million and 28 million lbs., respectively, in the corresponding period of the preceding year.

The production of coarse yarn (Nos 1 to 25) in May was 54 million lbs., of medium counts (Nos. 26 to 40) 8 million lbs., and of fine counts (above No. 40) 431,000 lbs., as against imports from foreign countries of only 281,000 lbs. of coarse, 1,733,000 lbs. of medium, and 731,000 lbs. of fine counts.

The production of Indian weaving mills during May consisted chiefly of the description of goods stated below (in thousands of yards):—

Grey and bleached piece-goods:—

Shirtings and longcloth	44,842
T-Cloths, domestics and sheetings	5,774
Dhoties	35,818
Chadars	4,257
Coloured piece-goods	45,956

The following statement compares the production (in thousands of yards) of piece goods woven in Indian mills during the month with the imports of such goods from foreign countries: —

	Production.	Imports.
Grey and bleached piece-goods.. ..	109,880	113,307
Coloured piece-goods	45,956	27,026

The value of goods woven in Indian mills in May, as far as reported, was Rs. 4,67,00,000, in which the share of the Bombay cotton mills was Rs. 11,38,240.

The value of cotton goods imported from foreign countries during the month was Rs. 5,77,00,000.

The exports of Indian yarn to foreign countries during April and May, 1924, were 5,000,000 lbs., as compared with 7,000,000 lbs. and 10,000,000 lbs. in the corresponding periods of 1922-23 and 1921-22, respectively.

The excise duty realised on woven goods during the month of May amounted to Rs. 15 lakhs.

GENERAL NOTE.

Water Power Exhibition at Basel.—According to the *Times Trade and Engineering Supplement*, the arrangements for the International Exhibition of Inland Navigation and Water Power which will take place at Basel from July 1st to September 15th next, are proceeding actively. Nearly all the big Swiss manufacturers, as well as the Federal Railways Department, have agreed to participate. Amongst foreign countries, Belgium, Germany, France, Holland, Italy, Yugoslavia, Austria, and Czechoslovakia are also making a display. Negotiations are being carried on with Canada, Great Britain, Norway, Sweden, Hungary, and the United States with a view to obtaining their support. In France the Government has appointed a special Committee for this exhibition. France, Germany, Holland and Italy have all taken space for a display by their respective Governments and private firms. The Transport Committee of the League of Nations and the International Labour Bureau will also be represented. The World Power Conference will hold a special meeting during the course of the exhibition. International discussions will be arranged on such subjects as the use of electricity in agriculture, railway electrification, inland navigation and the utilization of water power, and international exchange of power.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 18..Architects, Royal Institute of, British, 9, Conduit Street, W. 8 p.m. Criticism by Mr. H. S. Goodhart-Rendel on work submitted.

Electrical Engineers, Institution of, at the University, Liverpool. 7.30 p.m. Mr. A. P. Trotter, "Illumination and Light."

At Cleveland Technical Institute, Middlesbrough. 7.15 p.m. Messrs. E. E. Dunn and W. S. Ramsdale, "The Isolation, Location, and Repairs of Faults."

Faraday Society, Burlington House, Piccadilly, W. 5.30 p.m. Mr. B. B. Banerji, "The Electrode Capacity and Resistance of Electrolytes for a Wide Range of Frequencies." Messrs. J. A. V. Butler, W. E. Hugh and D. H. Hey, "The Effect of the Electrode Material on Oxidation Potentials." Mr. R. E. W. Maddison, "The Electromotive Behaviour of Cupric Oxide." Mr. A. Highfield, "The Colloidal Properties of Nitrocellulose Sols in Mixed Solvents." Messrs. E. P. Perman and T. Lovett, "Vapour Pressure and Heat of Dilution of Aqueous Solutions." (Part I.) (a) "Vapour Pressure of Aqueous Solutions of Urea." (b) "Heat of Dilution of Aqueous Solutions of Urea." Mr. W. Taylor, "A Note on Kinetic Activation as a Factor in Gas Reactions."

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Report and Discussion on the New Photo-Theodolite of Mr. H. Wild.

Transport, Institute of, at Queen's Hotel, Birmingham. 6 p.m. Mr. J. H. Kirk, "Commercial Horse Transport."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Otakar Vocadlo, "Some Aspects of Czechoslovakia." (Lecture I.)

At University College, Gower Street, W.C. 4.30 p.m. Mr. Henry Higgs, "Some Social Problems in the Light of Economics and Statistics." (Lecture I.)

5.30 p.m. Mr. M. H. Krishna, "Indian Archæology and Anthropology." (Lecture I.)

At King's College, Strand, W.C. 5.30 p.m. Dr. F. A. P. Aveling, "The Human Will." (Lecture I.)

TUESDAY, JANUARY 19..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.15 p.m. Discussion, "Periods in Indian History."

Electrical Engineers, Institution of, at College of Technology, Manchester. 7.30 p.m. Mr. A. P. Trotter, "Illumination and Light."

At the College, Loughborough. 6.45 p.m. Mr. A. B. Mallinson, "Justifiable Small Power Plants."

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. W. Blane, "Poetry and the Engineer."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Prof. F. C. Thompson, "The Principles which Govern the Heat Treatment of Non-Ferrous Alloys."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Messrs. Baldsiefen, Sease, and Renwick, "The Behaviour of Silver Iodide in Iodo-Bromide Emulsions."

Philosophical Studies, British Institute of, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. J. A. Crowther "X-Rays and Living Matter."

Statistical Society, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Mr. R. J. Thompson, "The Productivity of British and Danish Farming."

Transport, Institute of, at Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Mr. H. Koaze, "Relations between the State and Railways in Japan."

University of London, at the London School of Economics, Aldwych, W.C. 5 p.m. Dr. J. Bonar, "Adam Smith and the Classical Economists."

At University College, Gower Street, W.C. 5.30 p.m. Dr. E. G. Richardson, "Acoustics of Buildings." (Lecture I.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture I.)

WEDNESDAY, JANUARY 20..British Academy, Burlington House, Piccadilly, W. 5 p.m. Mr. C. R. Peers, "English Ornament in the VIIth and VIIIth Centuries."

Constructive Birth Control, Society for, Essex Hall, Essex Street, W.C. 8 p.m. Mr. L. Jefferson, "Religion and Birth Control."

Electrical Engineers, Institution of, at Royal Victoria Hotel, Sheffield, 7.30. Address on "Regulations," by Messrs. Nelson, Walker, Rait and Davies.

Entomological Society, 41, Queens Gate, S.W. 8 p.m. Annual Meeting.

Geological Society, Burlington House, Piccadilly, W. 5.30 p.m. Mr. T. O. Morris and Prof. W. G. Fearnsides, "The Stratigraphy and Structure of the Cambrian Slate-Belt of Nantlle (Carnarvonshire)."

Meteorological Society, 49, Cromwell Road, S.W. 7.30 p.m. Mr. C. J. P. Cave, Presidential Address.

University of London, at University College, Gower Street, W.C. 5.30 p.m. Sir Theodore Piggott "Insanity, Legal and Medical."

5.30 p.m. Mr. W. C. Berwick Sayers, "Book Selection for Children."

At King's College, Strand, W.C. 5.30 p.m. Mr. H. W. V. Temperley, "George Canning."

At University College, Gower Street, W.C. 3 p.m. Prof. E. G. Gardner, "The Purgatorio of Dante." (Lecture I.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Earliest Civilisation of the Slavs." (Lecture I.)

THURSDAY, JANUARY 21..Antiquaries, Society of, Burlington House, Piccadilly, W. 8.30 p.m.

Aeronautical Society, 7, Albemarle Street, W. 6.30 p.m. Major J. S. Buchanan "The Schneider Cup Race, 1925."

Chemical Society, Burlington House, Piccadilly, W. 8 p.m. Messrs. R. G. W. Norrish and G. G. Jones, "Studies of Valency. Part VII. Surface polarity and the reaction of ethylene and chlorine. The effect of the adsorbed water layer." Messrs. W. Charlton, W. N. Haworth and S. Peat. "A Revision of the Structural Formula of Glucose." Messrs. J. G. F. Druce and F. H. Loring, "Dvi-manganese." Messrs. R. Forsyth, V. K. Nimkar and F. L. Pyman, "The Nitration of Benzamidines."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Messrs. J. L. Thompson and H. Walmsley, "Notes on the Testing of Static Transformers."

At Trinity College, Dublin. 7.45 p.m. Mr. A P. Trotter, "Illumination and Light."

Mining and Metallurgy, Institution of, Burlington House, Piccadilly, W. 5.30 p.m.

Royal Society, Burlington House, Piccadilly, W. 4.30 p.m.

Royal Institution, 21 Albemarle Street, W. 5.15 p.m. Prof. C. J. Patten, "The Language of Birds."

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Mr. G. P. Baker, "Printed Textiles."

Illuminating Engineering Society, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7 p.m. Mr. Eric Farmer, "The Lighting of Coal Mines."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. S. Smith, "Early Arabian Tribes" 5.30 p.m. Mr. Arundell del Re, "Chaucer and Boccaccio." (Lecture II.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk-Mirsky, "Early Russian Literature." (Lecture II.)

Tropical Medicine and Hygiene, Royal Society of, 11, Chandos Street, W. 7.45 p.m. Dr. Hasson, "New Procedure in the Diagnosis and Treatment of Leprosy." Col. W. P. Macarthur, "Old-time Plague in Britain."

Optical Society at Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m. Mr. R. Kingslake, "The Interferometer Patterns due to the Primary Aberrations."

FRIDAY, JANUARY 22..Mechanical Engineers, Institution of, Storey's Gate, St. James's Park, S.W. 6 p.m. Prof. A. H. Gibson, "Piston Temperatures and Heat Flow in High-Speed Petrol Engines."

Brown-Firth Research Laboratories, Sheffield. 7.30 p.m. Mr. A. V. Kemp, "Modern Developments in Open Hearth and other Steelworks Furnaces."

Physical Society, at Imperial College of Science, South Kensington, S.W. 5 p.m. Prof. T. H. Laby, "A Critical Discussion of the Determinations of the Mechanical Equivalent of Heat." Mr. F. I. G. Rawlins, "The Present Status of Theory and Experiment relating to Specific Heats and the Chemical Constant."

Société Internationale de Philologie, Sciences et Beaux-Arts, 8, Taviton Street, W.C. 8.15 p.m. Prof. I. O. Stefanovich, "The Tentacular Ear and some Remarks on Sounds."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir William Bragg, "The Work of the Davy Faraday Research Laboratory."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Andrew Andréadès, "Disraeli and Greece."

At University College, Gower Street, W.C. 5.30 p.m. Miss Eleanor Hull, "Ireland from the Earliest Times." (Lecture I.)

SATURDAY JANUARY 23..Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. H. Balfour, "The Evolution of Currency and Coinage."

L.C.C. Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "Europe's Debt to the Ancient Egyptians."

No. 3818. JANUARY 22, 1926. Vol. LXXIV.

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OF THE
ROYAL SOCIETY OF ARTS

CONTENTS:

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: SOME CANTOR : AND OTHER LECTURES.

Recently delivered before the Royal Society of Arts.

(Cobb Lectures.) Certain Fundamental Problems in Photography. Three Lectures. By T. Slater Price, O.B.E., D.Sc., F.R.S. (1924). Price 3s.

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3818 VOL. LXXIV.

FRIDAY, JANUARY 22nd, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 25TH, at 8 p.m. (Cantor Lecture.) H. P. SHAPLAND, A.R.I.B.A., Editor of the *Cabinetmaker*, "The Decoration of Furniture." (Lecture II.)

WEDNESDAY, JANUARY 27TH, at 8 p.m. (Ordinary Meeting.) PROFESSOR JOHN McLEAN THOMPSON, D.Sc., F.R.S.E., Professor of Botany, University of Liverpool, "Some General Problems of the Transport by Sea and Conservation in Store of Ripe Fruit." (Aldred Lecture). SIR HALFORD MACKINDER, Chairman of the Imperial Shipping and Imperial Economic Committees, will preside.

DR. MANN JUVENILE LECTURE.

Under the Dr. Mann Trust PROFESSOR HENRY E. ARMSTRONG, F.R.S., presented, on Wednesday afternoon, January 13th, the second act of "Alice in Wonderland at the Breakfast Table," a drama in which the dialectical absurdities which Lewis Carroll puts in the mouth of his characters were replaced by a scientific dialogue, illustrated by various experiments, the object of which was to reveal a corner of the Wonderland of Science. The play opened with the emergence of Alice from a very realistic rabbit-hole after Professor Armstrong had thrown a mushroom down it to enable her to get out, and the Duchess, the Mad Hatter, the Dormouse, and Brer Rabbit, seated round a breakfast table with the Cook in attendance, proceeded to discuss the nature of chalk, lime, and acid. The discussion, which went hand in hand with experiments with all sorts and kinds of shells—oyster, scallop, mussel, egg, and snail shells—revealed the fact that all these are really nothing but "chalky stuff," and showed how the crust of lime in a bottle and the "fur" inside a kettle are dissolved by acid. In the course of this enquiry it was discovered that "most of the food we eat is fizz-gas and so we keep ourselves warm."

The play was greatly appreciated by the juvenile portion of the audience, while in some of the older generation of less scientific bent, arose vivid memories of childhood, of anxious but pleasurable moments when they watched a mixture of sugar, butter, and treacle in the frying-pan, and wondered whether it would or would not assume the characteristics of real toffee; and of those equally happy hours spent in making ice-cream in an old tin—an occupation into which speculations as to whether enough or too much salt had been put into the freezing mixture invariably entered. The young ladies and gentlemen of Professor Armstrong's Company and in their audience will at any rate be relieved of all such embarrassments, and will be provided with an effective reply to parental objections in saying that they are checking the results of scientific experiments which they have seen carried out by Professor Armstrong at the Royal Society of Arts. At the end of the performance a vote of thanks to Professor Armstrong and his talented Company was proposed by Sir Robert Hadfield, Bt., D.Sc., F.R.S., and carried by acclamation.

COUNCIL.

A meeting of the Council was held on Monday, January 11th. Present:—Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Sir Frank Baines, C.V.O., C.B.E.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Viscount Bearsted, LL.D.; Sir William Henry Davison, K.B.E., D.L., M.P.; Sir Archibald Denny, Bt., LL.D.; Peter MacIntyre Evans, M.A., LL.D.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Major Sir Humphrey Leggett, D.S.O., R.E.; Sir Philip Magnus, Bt.; Alan A. Campbell Swinton, F.R.S.; Carmichael Thomas; Professor J. M. Thomson, F.R.S.; Sir Frank Warner, K.B.E., and Sir Alfred Yarrow, Bt., F.R.S., M.Inst.C.E., with Mr. G. K. Menzies, M.A. (Secretary) and Mr. W. Perry, B.A. (Assistant-Secretary).

A letter from Lord Stamfordham, conveying the thanks of His Majesty the King for the message of sympathy from the Council on the death of Queen Alexandra, was read. (See *Journal* of December 18th, 1925, pages 101-2.)

The appointment of Mr. William Perry, B.A.(Oxon.), formerly Fereday Fellow of St. John's College, Oxford, as Assistant Secretary of the Society and Secretary of the Indian and Dominions and Colonies Sections, was reported and approved.

The terms of the offer of a Prize of £50 under the Thomas Gray Memorial Trust "for an Improvement in the Science or Practice of Navigation," were approved. (See below.)

Particulars of the Competition of Industrial Designs, 1926, were laid on the table.

Papers offered for reading at the Society's meetings were considered.

Sir Frank Baines, C.V.O., C.B.E., as nominated to serve as the Society's representative on the Board of Architectural Education.

Other financial and formal business was transacted.

THOMAS GRAY MEMORIAL TRUST.

PRIZE FOR AN IMPROVEMENT IN THE SCIENCE OR PRACTICE OF NAVIGATION.

Under the terms of the Thomas Gray Memorial Trust the Council of the Royal Society of Arts offer a Prize of £50 to any person who may bring to their notice a valuable improvement in the Science or Practice of Navigation proposed or invented by himself in the year 1926 or in the years 1921-5 inclusive. Preference will be given to an invention of 1926.

In the event of more than one such improvement being approved, the Council reserve the right of dividing the amount into two or more prizes at their discretion.

Competitors must forward their proofs of claim on or before December 31st, 1926, to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

COAL ASH AND CLEAN COAL.

By R. Lessing, Ph.D., M.I.Chem.E.

Lecture II.—*Delivered November 30th*, 1925.

In the first lecture we discussed mineral matter in its relation to the formation and constitution of coal and some of the methods employed in the study of its distribution throughout the coal mass. The object of to-night's discourse is to examine the bearing of mineral matter upon the production of coal.

The minerals which have perhaps the most profound influence on the mining of coal are the rocks constituting the roof and floor of a coal seam. For, on the physical nature of the strata overlying the coal depends the ease or difficulty of working any given seam. Strength and compactness of these rocks permit the coal to be extracted in safety with a reasonable amount of underpinning, whilst a smaller degree of cohesion and rigidity may cause, under the tremendous pressure of the superincumbent strata, falls of roof, a danger responsible in its cumulative effects for as many or more mining casualties than the more spectacular accidents due to explosions or flooding.

A more or less sharp line of demarcation between coal and rock at the top

and bottom of a seam determines the ease with which a tolerably clean coal can be "got."

The adventitious impurities are, however, not only due to the mineral deposits confining the seam. Many bituminous coal seams in this country, at any rate, contain dirt bands, *i.e.*, layers of incombustible or high-ash material deposited parallel to the bedding plane. They may vary in thickness from almost imperceptible films to veins of a depth which practically divide the coal below and above them into separate seams.

These "partings" are composed either of carbonaceous shale or in the case of the thinner ones, of calcite or ankerites, *i.e.*, substituted calcium carbonates, containing iron, manganese or magnesium.

Another extraneous impurity is the substance filling the cleat or cracks approximately at right angles to the bedding plane, probably produced by earth movements after coal formation was completed or well on its way to this stage. This white substance is practically identical with the calcite or ankerite of the "partings" and very similar in composition to the material filling the pores of fusain in the same seams. The evidence so far available shows these compounds to be due to the infiltration of "hard" water into the cracks and fissures of the coal mass.

Some representative analyses are shown in the following table:—(24)

TABLE IV.

Locality	Garswood	Garswood	Garswood	Bickershaw
Seam	D2	D2	D2	—
Sample	1	3	4	—
	Per cent.	Per cent.	Per cent.	Per cent.
CaO	35.17	41.10	29.94	29.90
MgO	9.03	Nil	16.15	10.86
FeO	11.35	13.18	5.21	13.67
MnO	Nil	3.07	1.11	1.21
CO_2	44.45	42.06	44.58	44.48
SiO_2	Nil	Nil	2.25	Nil
Fe_2O_3	—	—	0.25	0.12
SO_3	Nil	0.36	0.26	Nil
Equivalent to				
$CaCO_3$	62.80	72.95	53.14	53.39
$MgCO_3$	18.88	Nil	33.77	22.71
$FeCO_3$	18.30	21.25	8.40	22.04
$MnCO_3$	Nil	4.97	1.80	1.96
SiO_2	Nil	Nil	2.25	Nil
Fe_2O_3	—	—	0.25	0.12
$CaSO_4$	Nil	0.61	0.44	Nil

(24) Phys. and Chem. Survey of the Nat. Coal Resources, No. 4. The Ravine Seam, Part I. Fuel Res. Board, 1925.

CHEMICAL METHOD OF COAL GETTING.

In the early work directed to separating and characterising the coal components fusain, durain, clarain and vitrain, it was found desirable to retain as far as possible the morphological and chemical character of the particles, and fine-grinding was, therefore, reduced to a minimum. In the endeavour to effect a more complete separation of these coal ingredients, treatment with acid was applied to coal in lump form or in a roughly crushed state.(25) The surprising discovery was then made that coal so treated became brittle, and could be easily crushed between the fingers. This result was obtained with acids of a concentration which practically excluded the possibility of a reaction with the organic matter in the coal, and one was forced to the conclusion that the acid acted merely on some of the mineral constituents. It was found that the disintegration of the massive coal was due, in the first instance, to an attack of the acid on the cleat and partings, and that, therefore, these must be considered as the bond by which the coal conglomerate is cemented together.

The fact that disintegration takes place practically throughout the mass of coal, and not merely along the interfacial layers of visible partings, goes to prove that bituminous coal is intersected by a multitude of microscopic and immeasurable fissures that are filled with material of a composition similar to the calcium or ferrous carbonates (ankerites) forming the bulk of the separable partings. The latter are, however, more easily acted upon, and it may be said that thickness and accessibility are a measure of the ease with which these substances yield to treatment with acid.

The decomposition of interstratified carbonates by the reacting acids results in the formation of salts of these acids, whereby their rock-like structure is destroyed and the bond which they form between faces of the coal substance is loosened. This explanation of the phenomenon finds support in the statement by Sinnatt, Grounds and Bayley (26) that ankerites form a distinct line of weakness in the coal.

It was found, in the first instance, that a preliminary treatment of crushed coal with acid permitted a cleaner separation of the four coal components. It also provided an easy means of cleaving large blocks of massive coal by running dilute hydrochloric acid drop by drop along a pronounced ankerite parting.

Proceeding a step further, the application of a gaseous acid was tried and sulphur dioxide was found to act on the partings so that the various layers could be lifted away from each other.

The process has been proposed as a new method of winning coal (27) and

(25) Trans. Inst. Min. Eng., 1923, *64*, 296.
(26) J. Soc. Chem. Ind., 1921, *40*, 1T.
(27) Brit. Pat. No. 173, 072, of Sept. 23, 1920.

experiments have been made with it in a number of collieries in this country and in America. The method of procedure is to drill bore holes of rather smaller diameter than those used for explosives, into the coal face and to pass sulphur dioxide gas, dry or moistened, into the holes by means of flexible tubes, tightly stemmed into the opening (Fig. 7). The sulphur dioxide is taken from

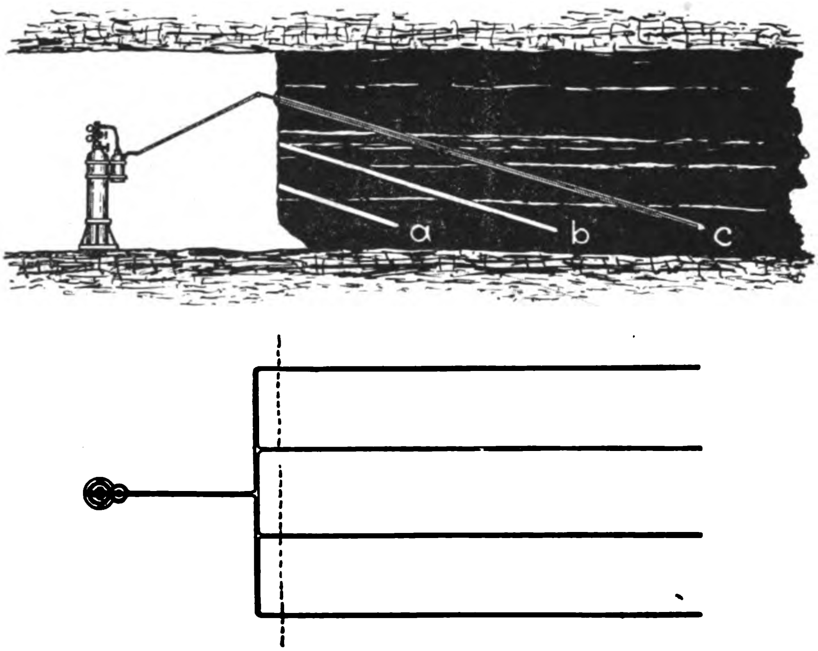

FIG. 7.

ordinary compressed gas cylinders and reduced to atmospheric pressure, no blasting action being involved, unless the change in density brought about by the conversion of the carbonates into sulphites may be classed as such.

It is not claimed that the process has as yet arrived at a stage of commercial perfection, but the trials made so far have produced sufficient results to warrant intensive investigation and the active co-operation of the mining engineer with the chemist for its further elaboration.

SPONTANEOUS COMBUSTION OF COAL.

In the discussion of my paper on "The Disintegration of Coal by Acids," Mr. S. L. Thacker (28) suggested that this reaction may furnish material for an explanation of the cause of the spontaneous combustion of coal and directed attention to the likelihood of the acid formed upon oxidation of pyrites acting in a similar way.

(28) Trans. Inst. Min. Eng., 1923, *64*, 306.

The problem of spontaneous combustion of coal, whether underground, in storage or in ships' holds or bunkers, still awaits complete solution. The social and economic importance of this phenomenon, as a source of danger to life and limb and a cause of financial loss, has been the incentive to a considerable amount of investigation, theorising, and official inquiry. The controversy as to whether oxidation of pyrites or oxidation of the organic coal substance may severally or jointly be held responsible is still to be adjudicated. The final report of the Departmental Committee on Spontaneous Combustion of Coal in Mines, issued in 1922, largely negatived the influence of pyrites beyond its causing disintegration and thus exposing a greater surface of coal substance to oxidation. More recent work by Graham (29) and by Sinnatt and Simpkin (30) proves that the action of pyrites must be considered at least a contributary and in certain cases even the initiating cause of self-heating and spontaneous combustion. It is, however, fairly well established that massive crystals of pyrites are very resistant to low-temperature oxidation and that only finely divided and disseminated iron sulphide, whether in the cubical form of pyrites or in the rhombic form of marcasite, is liable to it.

A shortcoming of the older discussions was that the oxidation products of pyrites were inadequately considered, and that oxidisable inorganic compounds in coal, other than pyrites, were not considered at all. Ferrous carbonate and particularly manganous carbonate, being of a basic character, are very liable to oxidation.

The free sulphuric acid formed in the reaction :—

$$2\ FeS_2 + 7O_2 + 2\ H_2O = 2\ FeSO_4 + 2\ H_2SO_4$$

which is generally believed to take place in the oxidation of pyrites, reacts with the ankerites with a two-fold result.

Firstly, it is neutralised and thus tends to permit ferrous sulphate to be oxidised by air. The secondary reduction of the resultant ferric sulphate by unoxidised pyrites or by coal substance involves, of course, the oxidation of further amounts of these substances.

Secondly, the action of the free sulphuric acid upon the carbonates of the cleat and partings is nature's application of the process of disintegration discussed above, and it need hardly be emphasized that disintegration is the fundamental condition for making spontaneous combustion possible.

The reactions here described presuppose the contiguity of the carbonates and pyrites, a condition frequently observed. Indeed, the conversion of the carbonate and sulphide into one another is hardly questioned. Whilst Sinnatt and Simpkin (30) leave the question as to the direction of the reaction open, their observation that the pyritic portion of a mixed parting was, and the

(29) Trans. Inst. Min. Eng., 1924, *66*, 41, 145; 1925, *67*, 100; 1925, *69*, 413. J. Soc. Chem. Ind., 1924, *43*, 79T.

(30) Lancs. and Chesh. Coal Res. Assoc., 1922, Bull. 12.

ankerite portion was not, in contact with the coal indicates sulphiding of the carbonate by sulphur from the coal substance, a view supported by chemical considerations.

Prevention of Explosions by Stone-Dusting.

The previous section will have made it sufficiently clear that in any inquiry into spontaneous combustion the reactions of the inorganic constituents of coal must be duly considered along with the oxidation of the coal substance itself. In another phase of safety work in mines mineral matter also plays an important role. Sir William Garforth suggested from the experience of the coal dust explosion at Altofts in 1885, which failed to penetrate roads covered with stone dust, that such incombustible dusts are efficacious in extinguishing explosion flames. The valuable research work done on the problems connected with this remedy, largely under the direction of Prof. R. V. Wheeler at the experimental station at Eskmeals, has led to its compulsory application under the Coal Mines Act. The precise mechanism of the action of stone dust is not yet known and much work remains to be done for its elucidation. Meanwhile it is at present accepted that the phenomenon is not a purely chemical one—the chemical nature of the dust being of little consequence—and that it consists of a physical "blanketing" action, which prevents the propagation of the explosion from one suspended particle to another.

Preparation of Coal for the Market.

Having dealt with the inorganic compounds in regard to safety problems in mining, their bearing on the commercial side of coal production remains to be discussed.

It may be said that the preparation of coal for the market consists almost entirely of the removal of mineral matter from the coal brought to bank, for even the sizing of coal by screening, in effect, brings about a differentiation in ash percentage, whilst the third operation, *i.e.*, the drying of washed coal, has as yet not been adopted in this country, except in isolated cases.

The removal of shale or dirt begins underground, for the collier is constrained under the existing system of working to load and send to the surface coal reasonably free from "dirt." The wisdom of this method of working may be questioned, particularly from the point of view of coal conservation, but a re-organisation of the industry in this respect, desirable as it is, would involve the increase of haulage underground, winding, screening and cleaning facilities, and a considerable improvement of the methods in vogue to-day or the adoption of new and more efficient ones.

In considering the whole question of ash removal it should be remembered that the total truly inherent ash in the four coal components does not amount to more than 3 per cent. in most co[illegible] the clarain and vitrain fraction actually

carrying only about 1.5 per cent. Strictly speaking, that portion of the fusain and durain ash which is not derived from the original vegetable raw material may not deserve to be included. The bulk of the ash in the coal of commerce which amounts to from 7 to 12 per cent. and may rise to 20 per cent. or more in the case of slack or other smalls, consists of adventitious impurities which are associated with the coal *in situ*, *i.e.*, roof, floor and dirt bands, cleat and partings consisting of calcite or ankerite, and of pyrites. These three classes of impurities form the "dirt" and though not constituting, as a rule, a large portion of the bulk, they contribute by far the preponderating percentage of ash to the total.

As a first step in the preparation for the market of coal which is not sold and shipped as "through-and-through" coal, it is screened for the purpose of separating the large coal, sizing the smaller lumps, and particularly for the removal of slack (duff, dross, dant, etc.), in which mineral matter is more concentrated. After screening, lumps of shale and pyritic rock are hand-picked by boys or women whilst the coal is travelling over picking belts.

As regards large coal, I have come to the conclusion that its higher market value is not due to its physical form, *qua* size, but to the buyer's unconscious knowledge that the fact of its remaining unbroken in the operations of mining, handling and transport is a guarantee of its comparative freedom from ash. For the high ash in slack is mainly, if not entirely, due to the greater fragility and friability of the dirt bands and partings, and these or their fragments get concentrated in the smaller sizes. Hence the buyer's preference for large coal, which, once secured, he usually proceeds to break up before use.

On the other hand, the coal particles in the slack which are in mechanical admixture with the dirt are as free and perhaps freer from ash than the average lump of large coal of the same kind, and this fact forms the basis of all washing and cleaning processes.

Time does not permit of my entering into a detailed description of the plants and methods now in use. A comprehensive survey was made in the paper by Sinnatt and Mitton (31), given before the Empire Mining and Metallurgical Congress, 1924. If reference is also made to the paper on the same subject by Louis (32), in 1911, it will be found that some progress has been made during recent years, though both quantitatively and qualitatively there is yet much room for improvement of plant and methods.

It may suffice to review briefly the principles upon which the various processes are based.

The Jig Washer long used in the dressing of fine ores was adopted for coal washing by Bérard in 1850; a number of modifications were introduced from time to time, but the acting principle has remained the same. A pulsating

(31) Trans. Inst. Min. Eng., 1924, 67, 481.

(32) J. Soc. Chem. Ind., 1911, 30, 662.

motion is given to water on one side of the washing box, and is transmitted to the other side, where the raw coal is fed on to a grating. The mixed particles are thereby rapidly lifted to a height proportional to their size and then allowed to fall slowly, those of higher specific gravity falling to the bottom, whilst the coal particles remain suspended and overflow with the current of water over the weir-shaped side of the box. In some washers the pulsations are given by plungers (Fig. 8), in others, like the well-known Baum washer, compressed air is used for this purpose (Fig. 9).

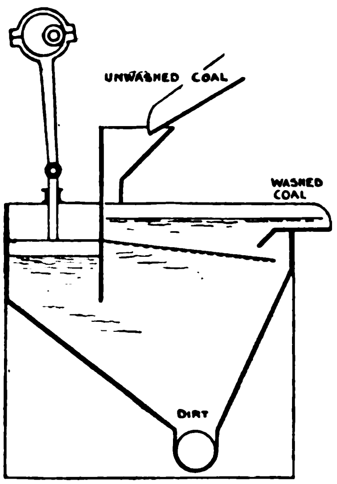

FIG 8.

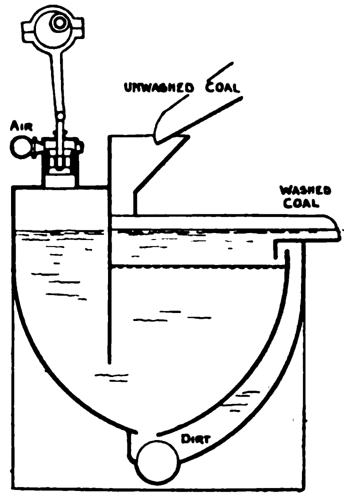

FIG. 9.

According to the law of bodies falling in water, say, as expressed by Rittinger's well known formula, the velocity of falling is proportional to the square root of the diameter and that of the difference between specific gravity of the particle and water. Size may therefore be of greater importance than specific gravity, and a large particle of low specific gravity and a small one of higher specific gravity may fall with the same velocity. For instance, a particle of pyrites of $\frac{1}{6}$in., one of pyritic shale of $\frac{1}{4}$in., one of shale of $\frac{1}{2}$in., and one of coal of 2in. diameter would all fall (or be floated) at the same velocity. These conditions require the material to be classified into close ranges of sizes, and each size to be washed separately if full advantage of the difference in specific gravities is to be obtained.

In *water-flow washers* differentiation between, and separation of, coal and ash-forming particles is brought about by a current of water moving without pulsations. The Draper washer (Fig. 10) is a true upward current elutriator, particularly applicable to fine coal. The Rheolaveur (Fig. 11) is a trough washer in which stratification of coal and shale is obtained by a stream of water moving horizontally, coal being carried forward whilst the "dirt"

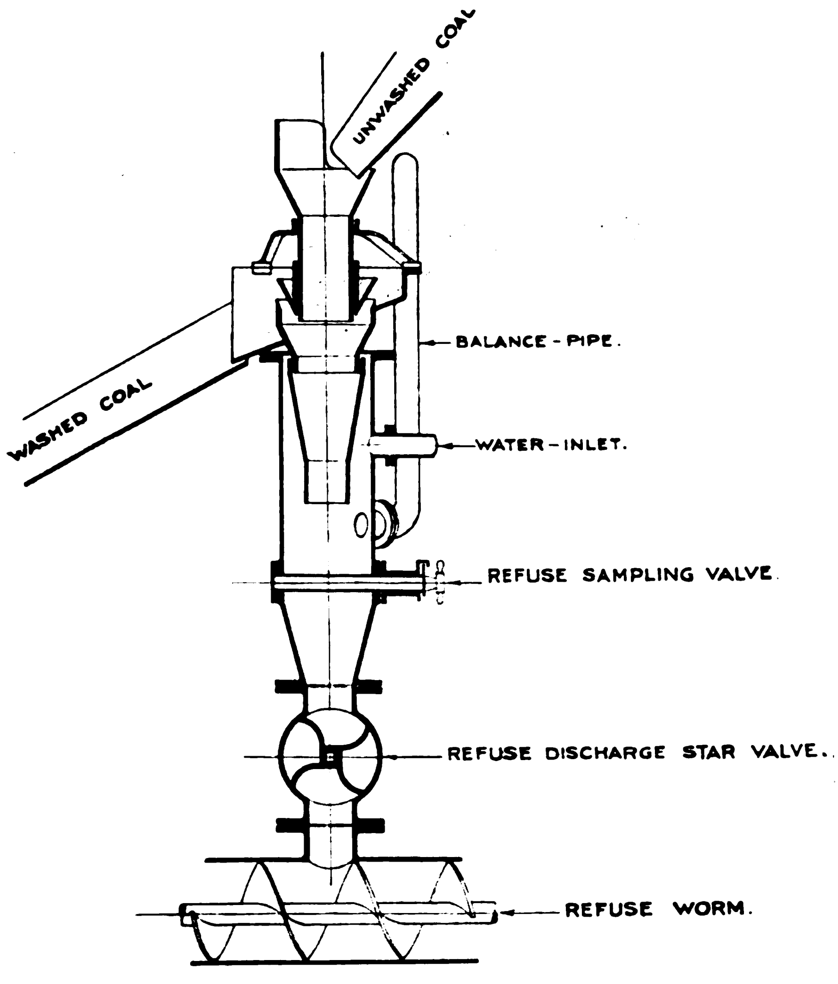

FIG 10.

sinks and is extracted at definite points through slots. The shale and pyrites drop through the slots against an ascending stream of water, which has sufficient velocity to lift the coal particles and prevent them from falling through, and then joins the horizontal current in the trough.

The physical characteristics of the particles are of paramount importance in all flow washers. Whilst coal particles approach cubical shape, shale occurs in flattened plates. In an upward current these plates tend to arrange themselves horizontally and are borne by the water along with coal of the same size, but smaller weight. Shale in the same position offers to an horizontal current of water a smaller cross-section, whilst coal particles offer

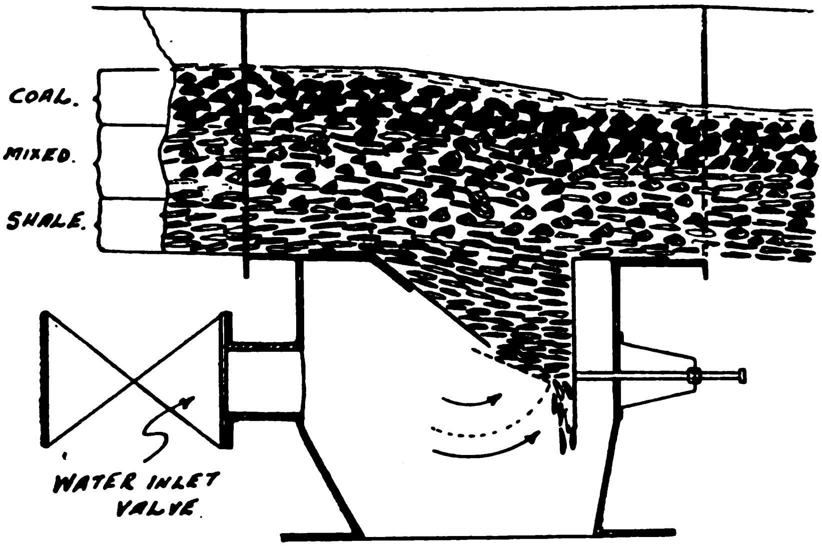

FIG. 11.

a larger surface in the direction of the stream and are thus carried further by reason of the difference in specific gravity and in physical shape. A close study of the " dirt " portion and its bearing on one or the other type of flow-washing is, therefore, very important.

WASHERY WATER.

A problem of considerable importance in connexion with coal washing is the study of the water used in and discharged from the plants. This water has suspended in it in form of a slurry the finest coal particles which comprise practically all the fusain contained in the coal. If the slurry, after settling out, is not returned to the clean coal, as is still frequently done, the latter should be clean in a literal sense of the word, inasmuch as it does not soil the fingers, whilst the slurry rich in fusain does.

The examination of washery waters with a view to their clarification and purification before return into the washing cycle or discharge as effluents, offers a wide field for future research, and is closely bound up with the distribution of mineral matter over the various coal fractions.

FLOTATION PROCESSES.

Coal washing by the jig or flow methods is based on the difference in specific gravities and size of coal and shale or other impurities. Oil or froth flotation which has been successfully applied to the concentration of sulphide ores is now used for coal cleaning. It discriminates between the impurities and coal, and, indeed, between various coal components, such as clarain and durain by their specific surface properties. A very small amount of frothing

agent, usually an oil of special qualities, is beaten into a pulp of fine raw coal in water. The coal particles attach themselves to the innumerable minute bubbles formed and rise to the top, whilst dirt particles sink or remain suspended or dispersed in the liquid. Different frothing agents will float individual components and clean bright and dull (bone) coal may thus be separated. The process is only applicable to fine coal below 1/10th inch in size.

In the Trent process very fine coal (passing through 200 mesh) is churned with water and about 20 per cent. of oil, with the result that the coal is selectively wetted by the oil and is agglomerated to pellets or nodules which can be strained off the water in which the mineral matter remains suspended. The necessity for recovering the large amount of oil or for finding a market for the unseparated "amalgam" will fit this process only to special local conditions. Batley (33) has shown that with light paraffin oils or benzol a reduction of 33 per cent. of the original ash content of a durain from the East Kirkby seam could be obtained by repeated treatment. The interesting point is that the abstracted mineral refuse had approximately the composition of kaolin, as had the ash from the "clean" durain itself, a further proof that the clay basis of durain is, from the constitutional point of view, not to be regarded as inherent ash.

Drying of Washed Coals.

A disadvantage of all coal washing processes is that the clean coal retains a considerable percentage of free moisture, which frequently is about equal in weight to the dirt in the raw coal. By this the fuel value is impaired and transport costs are not lowered. Of late, dewatering devices, mostly consisting of continuously working centrifugals, have been adopted to reduce the moisture content. The drying of the float from froth flotation presents a problem of its own on account of its fine sub-division, and the thin oil film enveloping the particles, whereby draining is impeded.

Dry-Cleaning of Coal.

With the object of avoiding the introduction of moisture, methods for dry-cleaning of coal have been elaborated in America, where the freezing of washed slack during severe frosts is a further difficulty to be considered.

The spiral separator is an apparatus largely used in the American anthracite field. It consists of a spiral inclined towards the centre post, down which the raw coal is allowed to slide. The combined differences in co-efficient of friction and shape of particles cause the shale to maintain its course on the innermost track of the spiral, whilst the coal moves towards its outer edge into the flanged coal spiral to be discharged separately from the shale (Fig. 12).

(33) Fuel, 1923, *2*, 236.

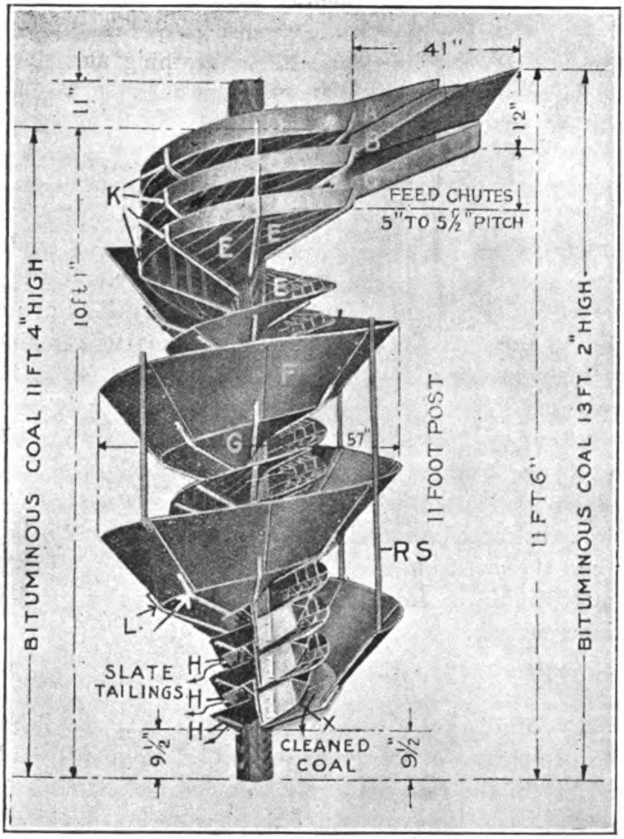

FIG. 12.

A recent development also emanating from America is the adaptation of the ore concentrating table for the cleaning of coal without the aid of water. The usual flow of water is replaced by a current of air blown through a flexible joint into a vibrating air chest, the top of which is covered by a permeab deck of woven wire cloth or perforated metal (Fig. 13). The surface of this deck carries riffles arranged roughly across the direction of the jigging motion by which the raw coal is moved forward, the angles from back to front and from side to side being adjustable. The coal fed on to the table is made more or less buoyant by the air passing upwards and through it, with the result that stratification takes place. The light coal particles are floated over the riffles and more towards the delivery shute; the heavier particles sink into the grooves formed by the riffles and move along these towards the plain part beyond the end of the riffles. "Middlings" are able to jump the riffles near their end, where strength of vibration and angle of throw permit them to do so. By fixing cutting fingers at predetermined points at the delivery end, the

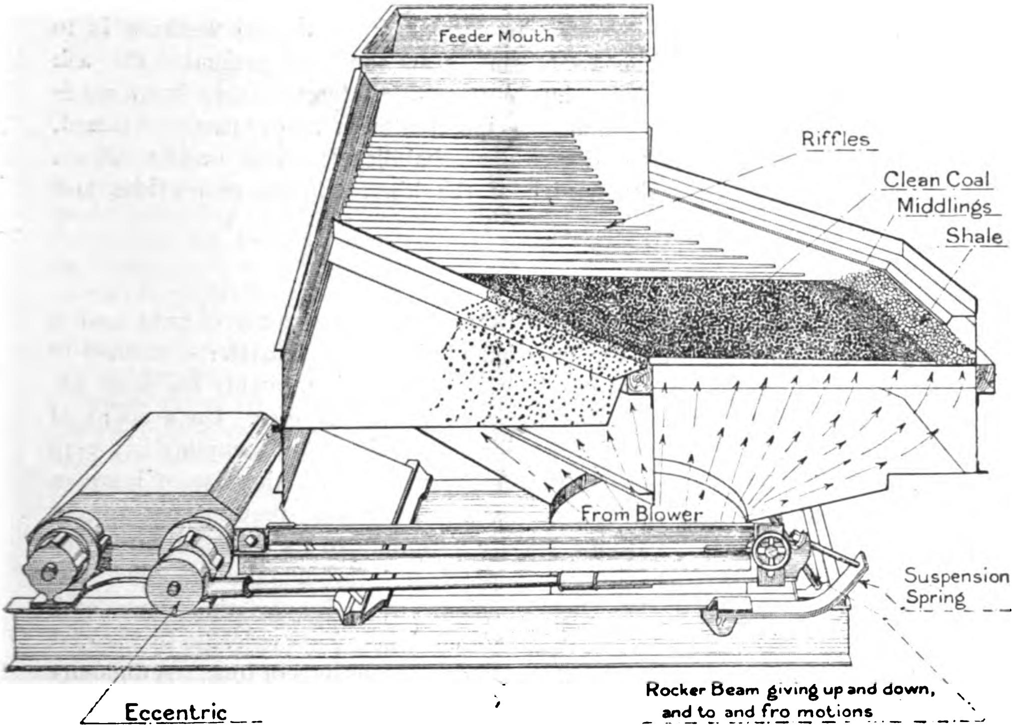

FIG. 13.

quality of the clean coal, middlings and dirt can be adjusted. The dust raised by the air current is collected by an exhausting system and recovered.

An essential condition for a sharp separation by this method is the close sizing of the coal and the use of finely adjusted tables for each size; this condition must probably be more strictly enforced in the case of air as a floating agent than where water is used. An experimental plant is now working in this country, and one of commercial size is in course of construction. The working results from these should be of great interest in view of the exclusion of added moisture from the cleaned coal.

THE CONTROL OF COAL WASHING AND CLEANING PROCESSES.

The various processes used or proposed for the improvement of the quality of coal depend on physical laws the theory of which in many cases still remains somewhat obscure. The amount of truly scientific research done on these questions is very small compared with the values involved. A first requirement for improvements in the preparation of coal in general, and washing and cleaning processes in particular, is a more extensive and more efficient control of existing plants. Many of these are run without chemical control, in others such control is of a casual and spasmodic character.

The principal method of controlling the work of a coal washery is to submit the products to float-and-sink tests and to estimate the ash percentages in the fractions thus obtained. Attempts have been made from time to time to apply mathematical treatment to the results obtained, but generalisations as to the degree of washability of coals usually fail on account of insufficient knowledge of the kind, relative proportions and distribution of the impurities.

COAL SAMPLING.

The problem of drawing representative samples for analysis from coal is intimately connected with the question of the mineral matter contained in it. The estimation of ash in consignments of coal is probably the most important item in its examination for commercial purposes. On account of the lack of homogeneity of its distribution, satisfactory sampling is a very difficult operation. As the ash percentage varies with the size of lump or particle, the ideal method of drawing samples would require that aliquot portions should be taken from each size according to its contribution to the bulk; this would involve, for example, where "through-and-through" coal is concerned, screening the whole consignment and quartering down each screening fraction, a proceeding which is obviously impracticable in the case of train loads or cargoes of several hundreds or thousands of tons. A difficulty in the case of ships' cargoes is the fact that on loading coal into a hold the large pieces tend to roll towards the base of the cone formed by the discharge of grabs, leaving the small coal near the apex or in the centre and top of the cone, so that the coal near the circumference of the base would show a lower ash content than that nearer the top. To allow for the segregation thus produced it is necessary to draw the samples from comparatively small units of weight before loading or by a similar subdivision on unloading. Where samples cannot be drawn continuously, say from elevator buckets or other small units, one has to fall back on the empirical knowledge and sense of proportion of the professional sampler, an expedient to be justified only by the concordant results which can be obtained between reliable men of long experience. In view of the increasing importance attached to the ash content of coal and the frequency of disputes arising, particularly in the case of export coal, it is highly desirable that the scientific basis of proper sampling should be more definitely established. It is to be hoped that the efforts in this direction of the Committee on Sampling of the Fuel Research Board will be crowned with success.

This cursory review of the treatment which coal undergoes at the colliery, prior to its being placed on the market, shows that practically every step in the chain of operations is closely bound up with problems for the solution of which a knowledge of its mineral constituents and associates and of their chemical and physical properties is indispensable.

NOTES ON BOOKS.

ENEMIES OF TIMBER: DRY ROT AND THE DEATH-WATCH BEETLE. By Ernest G. Blake. London: Chapman and Hall, Ltd. 12s. 6d. net.

The author treats his subject largely from the standpoint of the builder, and on pp. 60, 61, 67, 99 and 100 we find illustrations of methods for avoiding dry rot by promoting a free circulation of air, with avoidance of damp.

Although Mr. Blake includes the best or standard methods for the preventive treatment of new timber, also for the curative treatment of wood infected by fungus or insects, he does not seem to have completely eliminated from his chemical instructions all of those numerous errors and mistranslations so often met with when chemical details are gathered from many sources. For example, on page 125 and in reference to the furniture beetle, the author mentions various proposals, including the coating of the wood several times with sulphuric acid, and it is implied by the context that the sulphuric acid is sufficiently volatile to dry off. Sulphuric acid is actually a dangerously corrosive liquid which is not volatile at ordinary temperatures and is highly destructive to wood, furniture, and clothes. The reference to the *Deutsche Tischler-Zeitung* as the source from which were taken the fourteen lines given as a quotation on p. 125 would have been more valuable to a student or enquirer if page and date had been given.

THE THEORY OF MEASUREMENTS. By Lucius Tuttle and John Satterly. London: Longmans, Green and Co. 12s. 6d. net.

Here we have a remarkably thorough book covering for the most part fresh ground, and so occupying a new place in physical or laboratory literature.

Although the work consists of numerous theoretical aspects clearly and concisely stated, every one of these leads the student to the better performing of some laboratory duty; "better" sometimes in the sense of equally good results in less time, and in other cases an improved result.

Thus the authors embody practically a fundamental educational principle of Aristotle, that the "conscious purpose . . . . should be to learn rather than to accomplish" (p. 1).

Methods for avoiding waste of effort in the primary operations incidental to measurement are explained very aptly near the beginning of the book (pp. 15-20), and the lessons as to the degrees of accuracy embodied in Figs. 2, 3 and 4 are varied and instructive. In this connection we find much that bears on personal training and efficiency, as for example, in taking various compression and extension data as to one's own hand, so that it may serve as an ever-ready approximate measure. Turning to p. 32 and Fig. 10, we read of accuracy and speed when estimating and entering tenths or fifths of an ungraduated gap. The theory and use of the slide rule in its modern forms (pp. 60-62) is explained admirably and is followed by collateral studies in which various diagrams, graphs, logarithmic curves, and other aids are explained.

In treating of deviation and dispersion as bearing on averaging, our authors touch on "probable error," p. 194, and the plus-minus range which often qualifies a datum or a measurement; the number being the average and the plus-minus statement representing the dispersion of the average. The dispersion itself may possess special or unexpected qualities (*v.* "Relative Dispersion" p. 191 and foot-note p. 206). Thus the rejection or use of doubtful observations becomes a complex matter, which is treated of in a special chapter; but this subject overlaps into Chapter XXI., "Applications to Biology."

In turning over the 1863 edition of Nesbit's " Practical Mensuration," a work also published by Messrs. Longman and Co., we were impressed by the absence of overlap with the volume under notice. Nesbit's quite remarkable and comprehensive work, if skilfully adjusted and extended to present-day conditions, also cross-referenced with the work under notice, would make a valuable companion volume : while both together, if inter-indexed and unified, should form a treatise on measurement hitherto unparallelled.

COLLECTIVIST ECONOMICS. By James Haldane Smith. London : George Routledge and Sons, Ltd. 8*s*. 6*d*. net.

This is not a treatise on collectivist economics in the ordinary sense of the term, nor is it a collectivist romance in the style of Bellamy or of Fourier, but it is a surprisingly detailed and laboured account of the way in which the author thinks collectivism may arise and shape itself.

By collectivism is to be understood the public, national, or collective ownership of land and industrial capital ; but in its essential nature collectivism seems to be more like a debatable method in the dynamics of industry than a social or political principle on which a state can be founded. Degrees of collectivism appear to be essential in states whether monarchical or democratic, but if we glance back through the mists of history at attempts to introduce full-measure collectivism, we see failure and disruption ; a highly collectivised state appearing to be unstable or short-lived in the sense that it changes quickly, like an unstable chemical compound.

The author, in the *ex cathedrâ* scheme of collectivism now before us, makes the change from collectivism practically simultaneous with the introduction of collectivism : thus on p. 162 we read of " ownership of land and industrial capital by the nation," but with " each industry as a unity or guild holding in trust the land and the industrial capital appertaining to its functions." In short, the author's scheme of collectivism seems to be essentially identical with that of the nationalisation of Mines Bill, which was promoted by the Miners' Federation, but not accepted by Mr. Macdonald's Cabinet, and was finally rejected by the House of Commons on May 16th, 1924, by 264 votes to 168. This scheme of questionable or partial collectivism or nationalisation was promptly deprecated in many or most of the newspapers as being dangerously syndicalistic. The proposal, however, was put forward and lost in such short time that the slow-moving student of political economy had scarcely time to do more than to orientate his mind towards the fundamentals involved and the pages of history where elucidation may be hoped for. One notable period in history is that of Florence from 1265 to the Renaissance, and mainly in relation to the unity or guild as manifesting itself in more or less warlike industrial disturbances. In 1434 Cosimo de Medici returned in triumph after his banishment and re-established the political influence of his family. In extending this influence he became the first of a new dynasty of merchant princes to which civilisation owes much, and a study of the period of Cosimo and his successors discords somewhat with the author's remarkable ardour against the capitalist employer (pp. 27 and 212). The whole study lends support to Robertson's frequently quoted proposition, embodied in his " History of Scotland," as to acts of virtue and self-sacrifice which are occasionally made by individuals, but are not to be expected from any society of men.

The true collectivism of the British Marxian School is defined in a programme on p. 1262 of the Bliss Cyclopædia, 1897 edition, and the student can here read of democratic precautions then proposed for ensuring the absence of subversive

syndicalism. In the manifesto we read:—" All organisers or administrators to be elected by equal adult suffrage"; also " No project of law shall be binding till accepted by the majority of the people." Here we have the spirit, but not strictly the letter of the Swiss referendum, a system which has functioned quietly and satisfactorily during nearly a century, and, moreover, has been adopted in other states than Switzerland since the Great War.

HEXOSAMINES AND MUCO-PROTEINS. By P. A. Lavene. London: Longmans Green and Co. 10*s*. 6*d*. net.

This is an important addition to the Plimmer-Hopkins series of Monographs on Biochemistry, and it deals with the properties, functions, constitutions and relations of the nitrogenous sugars, a subject upon which the author has long been a leading authority.

In the preface it is pointed out that " the knowledge of the relationship between the chemical structure and the biological rôle is very fragmentary," and it is hoped that the present volume will " furnish another fragment."

The so-called carbohydrates, or amylaceous and saccharine compounds of the older chemists were long regarded as characteristically products of vegetable life, but Claude Bernard's research of 1848, in which he proved that a starch is a normal constituent of the liver, and also of the foetal tissues, was regarded with doubt until quantitatively proved by Luck, and out of this arose the theory of a glucosidic structure of the proteids; the keynote of the present valuable contribution to biochemistry.

CORRESPONDENCE.

THE FUTURE OF THE MOTOR CAR.

Your issue of January 1st contains a most interesting and instructive paper on " The Future of the Motor Car," by Sir Alan H. Burgoyne.

On page 143 he says " With a wisdom our own people have not been ready to emulate, every country but our own imposed heavy duties on imported cars, thus effectually stimulating home manufacture and absorption, and restricting the exploitation of their markets by competitive outside opponents."

On page 144 he gives the number of " heads of populations " for each motor (not cycles). Taking the figures for Europe they are as follows:—

United Kingdom ..	1 to 47
France	1 to 62
Germany	1 to 250
Italy	1 to 375

It appears, therefore, that the United Kingdom has absorbed more motor cars in proportion to the population than France, Germany, or Italy, and yet the United Kingdom is a country where they are less required, because the distances are less and the railway system is more perfect. In proportion to the population there are about four cars in England for three in France, and more than five cars in England for one in Germany, and eight cars in England for one in Italy.

Both the reader of the paper and the chairman apparently favour the import duty of 33-1/3% on cars, so that the farmer who would like an Italian car has to pay extra, but at the same time he has no protection against the import of foreign corn. If he had an import duty that would raise the 9d. loaf 33-1/3% to 1/-, would that meet with the approval of those who approve the import duty on cars?

ARNOLD LUPTON

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 25..Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. H. W. Clothier, "Impressions of my visit to America, mainly about Switchgear."
At Armstrong College, Newcastle-on-Tyne. 7 p.m. Captain P. P. Eckersley, "The Past, Present and Future Development of Wireless Telephony."
Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Mr. H. F. Lambart, "The Ascent of Mount Logan."
Société Internationale de Philologie Sciences et Beaux Arts, 8, Taviton Street, W.C. 3.30 p.m. Mr. F. G. Fraser, "Primitive Beliefs."
Victoria Institute, at Central Hall, Westminster, S.W. 4.30 p.m. Lt.-Commander V. L. Trumper, "Modern Science in the Book of Job."
University of London, at University College, Gower Street, W.C. 4.15 p.m. Prof. L. M. Brandin, "Le vilain d'après les fableaux."
At King's College, Strand, W.C. 5.30 p.m. Dr. Otakar Vocadlo, "Some Aspects of Czecho-Slovakia." (Lecture II.)
At University College, Gower Street, W.C. 4.30 p.m. Mr. Henry Higgs, "Some Social Problems in the Light of Economics and Statistics." (Lecture II.)
5.30 p.m. Mr. M. H. Krishna, "Indian Archaeology and Anthropology." (Lecture II.)
At King's College, Strand, W.C. 5.30 p.m. Dr. F. A. P. Aveling, "The Human Will." (Lecture II.)
University of London, at University College, Gower Street, W.C. 5.30 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture II.)

TUESDAY, JANUARY 26..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Anniversary Meeting.
Asiatic Society, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.30 p.m. Dr. A. M. Blackman, "Life in Hundred-gated Thebes."
Aeronautical Engineers, Institution of, at 39, Victoria Street, S.W. 6.30 p.m. Lieut. N. Oleeknovitch, "The Care and Maintenance of Tools as an important Factor in Workshop Routine."
Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Messrs. Arthur S. Angwin and Thomas Walmsley, "Rugby Radio Station."
Egypt Exploration Society, at Burlington House, Piccadilly, W. 8.30 p.m. Mr. Norman H. Baynes, "Alexandria and Constantinople: The Struggle Between Emperor and Patriarch."
Electrical Engineers, at the Hotel Metropole, Leeds. 7 p.m. Mr. L. H. A. Carr, "The Use of Induction Regulators in Feeder Circuits."
At the South Wales Institute of Engineers, Cardiff. 6 p.m. Mr. A. P. Trotter, "Illumination and Light."
Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. F. Arnold Best, "The Flettner Rudder"
Photographic Society, 35, Russell Square, W.C. Mr. Arthur S. Newman, "Three Fallacies in Kinematography."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. J. A. Crowther, "X-Rays and Living Matter." (Lecture II.)
Roman Studies, Society for Promotion of, at Burlington House, W. 4.30 p.m. Professor Stuart Jones, "Claudius and the Jewish Question."
Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Dr. Serge Zarchi, "The Psychology of Responsibility."
University of London, at the London School of Economics Kingsway, W.C. 5 p.m. Dr. Morris Ginsberg, "Adam Smith's Ethical Theory."
At King's College, Strand, W.C. 5.30 p.m. Prof. Dr. H. Gressmann, "The Problem of the Religious Development in Late Hellenistic-Judaism." (Lecture I.)
At University College, Gower Street, W.C. 5.30 p.m. Miss M. A. Murray, "Egyptian Architecture."
5.30 p.m. Dr. E. G. Richardson, "Acoustics of Buildings." (Lecture II.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture II.)

WEDNESDAY, JANUARY 27..Electrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Mr. C. E. Webb, "The Power Losses in Magnetic Sheet Material at High Flux Densities."
Metals, Institute of, at Temperance Hall, Temple Street, Birmingham. 7 p.m. Mr. W. R. Barclay, Metallurgy of Nickel with Special Reference to Work in Canada." (Joint Meeting with Birmingham Metallurgical Society.)
United Service Institution, Whitehall, S.W. 3 p.m. Colonel J. T. Villiers-Stuart, "The Nation in Relation to Its Armed Forces."
University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Charles Oman, "The Duke of Wellington."
At King's College, Strand, W.C. 5.30 p.m. Prof. Dr. H. Gressmann, "The Problem of the Religious Development in Late Hellenistic-Judaism." (Lecture II.)
At University College, Gower Street, W.C. 5.30 p.m. Miss A. M. Kihlbom, "Selma Lagerlöf."
3 p.m. Prof. E. G. Gardner, "The Purgatorio of Dante." (Lecture II.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Earliest Civilisation of the Slavs." (Lecture II.)

THURSDAY, JANUARY 28..Antiquaries, Society of, Burlington House, Piccadilly, W. 8.30 p.m.
Royal Institution, 21, Albemarle Street W. 5.15 p.m. Prof. C. J. Patten, "The Breeding Factor in Birds."
Royal Society, Burlington House, W. 4.30 p.m.
Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Mr. A. J. Koop, "Japanese Sword Furniture."
University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Dr. H. Gressmann, "The Problem of the Religious Development in Late Hellenistic-Judaism." (Lecture III.)
At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Customary Law in Europe." (Lecture I.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk-Mirsky, "Early Russian Literature." (Lecture III.)
At University College, Gower Street, W.C. 5.30 p.m. Dr. J. A. Hewitt, "Metabolism of Carbohydrate and Fat." (Lecture II.)

FRIDAY, JANUARY 29..Junior Engineers, Institution of, 39, Victoria Street, S.W. 7.30 p.m. Mr. A. N. Moon, "Comfort in Railway Travel."
Société Internationale de Philologie Sciences et Beaux Arts, 8, Taviton Street, W.C. 8.15 p.m. Dr. H. M. Léon, "The Island of Malta."
Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir W. B. Hardy, "On Films."
Structural Engineers, Institution of, at Great Northern Hotel, Leeds. 6.30 p.m. Mr. D. Davidson, "A New System of Reinforced Concrete Construction and Its Application to Foundations on Silt and Running Sand."
Transport, Institute of, at Lime Street Station Hotel, Liverpool. 6.30 p.m. Discussion on "Topical Transport Problems."
University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Andrew Andréadès, "Lord Salisbury and Greece."
At King's College, Strand, W.C. 5.30 p.m. Mr. G. B. Harrison, "Shakespeare's Actors."
At University College, Gower Street, W.C. 5.30 p.m. Miss Eleanor Hull, "Ireland from the Earliest Times." (Lecture II.)

SATURDAY, JANUARY 30..L.C.C., Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. H. Harcourt, "Glimpses of Indian Places and Peoples."
Metals, Institute of, and Institution of British Foundrymen, at Neville Hall, Newcastle-on-Tyne. 6.15 p.m. Joint Meeting.
Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. H Balfour, "The British Coracle and Its Affinities."

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REGISTERED AS A NEWSPAPER

Royal Society for the Encouragement of Arts, Manufactures, and Commerce.

The Royal Society of Arts was founded in 1754, and incorporated by Royal Charter in 1847, for the Encouragement of the Arts, Manufactures, and Commerce of the country.

At present the Society numbers about 3,500 Fellows. The annual subscription is Three Guineas, the life subscription Thirty Guineas. There is no entrance fee.

Fellows are entitled to be present at all meetings of the Society. These include the Ordinary Meetings, held every Wednesday during the Session, when papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed; the Meetings of the Indian and Colonial Sections, at which subjects connected with our Indian Empire and the Colonies and dependencies are considered, and the various lectures on technical subjects delivered under the Cantor and other trusts. Fellows also receive a weekly copy of the *Journal* which contains full reports of the Society's proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce; and they are entitled to the use of the library and reading room.

Proposal forms and further particulars relating to the work of the Society, may be obtained from the Secretary, Mr. G. K. Menzies, at the Society's House, John Street, Adelphi, London, W.C. (2).

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3819 VOL. LXXIV.

FRIDAY, JANUARY 29th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 1st, at 8 p.m.. (Cantor Lecture). H. P. SHAPLAND, A.R.I.B.A., Editor of the *Cabinetmaker,* "The Decoration of Furniture." (Lecture III.)

WEDNESDAY, FEBRUARY 3rd, at 8 p.m. (Ordinary Meeting.) SIR EDWARD JOHN RUSSELL, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station, "Investigations in Agricultural Science at Rothamsted." THE RIGHT HON. LORD CLINTON, Chairman, Lawes Agricultural Trust, will preside.

CANTOR LECTURE.

MONDAY, JANUARY 18TH, 1926. MR. H. P. SHAPLAND, A.R.I.B.A., delivered the first of his course of three lectures on "The Decoration of Furniture."

The lectures will be published in the *Journal* during the Summer recess.

SIXTH ORDINARY MEETING.

WEDNESDAY, JANUARY 20TH, 1926. SIR FRANK BAINES, C.V.O., C.B.E., in the Chair.

The following candidates were proposed for election as Fellows of the Society:

Victor Rice Arbogast, Paris, France.
Edward William Barton Wright, London.
Horace William Bickle, Plymouth.
E. Birkett, Brook, Ashford, Kent.
William Blackwell, Erdington, Birmingham.
H. S. Bonsor, B.Sc., Goniana, India.
Laurence Marsham Cockaday, New York City, U.S.A.
Rev. W. M. Coombs, Hulme, Manchester.
Colonel John Nathael de La Perrelle, D.S.O., M.C., London.
Daniel Oswald Oliver de Silva, Hongkong, China.
Hugo Gernsack, New York City, U.S.A.

Wyndham Collingwood Gray, London.
Rev. Charles Alfred Griffin, Ph.D., Litt.D., Warrington.
Rev. H. H. Hibbs, D.D., Smithland, Kentucky, U.S.A.
Captain Alfred Philip Hanby Holmes, M.C., B.Sc., Penang, Straits Settlements.
Alexander Edwards Hukins, London.
Charles F. Kenworthy, Woodbury, Conn., U.S.A.
Herbert Laurance Kitching, London.
Louis W. Klein, Chicago, Ill., U.S.A.
Kanhaiya Lal, B.A., Allahabad, India.
R. Lessing, Ph.D., F.C.S., M.I.Chem.E., London.
Professor John C. McLennan, Ph.D., F.R.S., Toronto, Canada.
Sir Evan Maconochie, K.C.I.E., C.S.I., Seaton, Devon.
E. Mallinckrodt, Junr., St. Louis, Mo., U.S.A.
Victor Emanuel Muncy, Cincinnati, Ohio, U.S.A.
David Pollock, London.
J. Aubrey Rees, London.
Aleck Leopold Rhodes, Port of Spain, Trinidad, B.W. Indies.
Dr. Leonard Robinson, C.B.E., Paris, France.
Dr. Arthur William Rogers, M.A., Sc.D., F.R.S., Pretoria, South Africa.
William Smith Rollo, Mandalay, Burma.
Sirdar Harbans Singh, London.
P. L. Sinha, Cawnpore, India.
Robert Archibald Starke, Herne Bay, Kent.
Knud Vendelbo-Knudsen, Buenos Aires, Argentine.
Robert W. Weidenbacker, Haverford, Penna., U.S.A.

The following candidates were duly elected Fellows of the Society:—
Frank Merricks, A.R.S.M., London.
Samuel Franklin Skellorn, Cape Town, South Africa.
Sir Gilbert T. Walker, C.S.I., Sc.D., F.R.S., Cambridge.

A paper on "Problems in Paint and Varnish Technology" was read by Dr. H. Houlston Morgan, Ph.D., B.Sc., F.C.S., President, Oil and Colour Chemists' Association. The paper and discussion will be published in the *Journal* of February 12th.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

COAL ASH AND CLEAN COAL.

By R. Lessing, Ph.D., M.I.Chem.E.

Lecture III.—*Delivered December 7th*, 1925.

INFLUENCE OF THE MINERAL CONSTITUENTS ON THE UTILISATION OF COAL.

The crucial test of the importance which I claim for the mineral matter in coal lies in its relation to the utilisation of the fuel. It is a truism to state that coal is employed for the thermal energy it is capable of generating, and

that, therefore, mineral matter which, with negligible exceptions (oxidation of iron and sulphur) is devoid of this property, is an undesirable, though, perhaps, unavoidable concomitant of it.

In introducing my subject, I have already, as an example of the economic drawbacks attaching to the inorganic impurities in coal, given an estimate of the cost of carrying them from the mine to the consumer. The disposal of the ash left after the coal or the coke produced from it, is burnt, cannot be so easily estimated, since the amounts to be dealt with are split up into units of widely varying magnitude and consequently the methods of disposal must differ very considerably. These amounts may vary from a charge of slag of many tons, run off in molten condition from a blast furnace, down to a few pounds of ashes raked from the domestic hearth and placed into the dust bin, involving house-to-house collection.

A small quantity of the total bulk may have a commercial value where, as in the case of power stations, factories, or other large consumers, the ashes find a sale for such purposes as road making, concrete mixing or preparing filter beds. Even here, where ashes may realise a market value of from sixpence to 2s. 6d. per ton, it is hardly permissible to regard the revenue thus obtained as profit, seeing that a multiple of these figures has been paid for the material when in association with coal.

Chemical and Physical Behaviour in Combustion Processes.

In examining the behaviour of mineral matter during the burning of coal it must be remembered that the course of the combustion process varies enormously from case to case. The depth of the fuel bed, the tightness or looseness of packing, the strength of chimney draught, the oxidising or reducing atmosphere, the temperature at different points of the bed and at different stages of the combustion process, and many other factors influence the chemical reactions and physical changes which may take place in the ash constituents.

The factor first to be considered is the total amount of ash-forming matter in the coal. It determines the degree of accessibility of air to the combustible substance, and hence the throughput of fuel in a given time under otherwise equal conditions. The larger the percentage of ash, the greater is the risk of leaving unburnt coal or coke in it. Moreover, the sensible heat retained by the ash, though not affecting the heat balance very seriously—it being of the order of 0.4 per cent. of the calorific value of a coal containing about 10 per cent. of ash—is directly proportional to this percentage.

The factor next in importance, and one of a more fundamental character, is the chemical composition of the ash. It affects the different phases of the combustion process in various ways. The burning of coal may be roughly subdivided into several stages, which overlap and otherwise influence each other:—(1) Carbonisation, (2) the combustion of the gases and vapours

thereby released, which may be accompanied or preceded by a secondary decomposition of these volatile compounds, (3) gasification of the carbon residue left after carbonisation, by its conversion into carbon monoxide and the burning of carbon monoxide to carbon dioxide. It is impossible by present means to isolate experimentally these different stages or even to determine their sequence with any degree of precision. It so happens, however, that every one of them is subject to the influence of catalysts, as will be shown later, and amongst the constituents of coal ash are elements which have been proved capable of catalytic activity.

The catalytic influence of inorganic compounds on combustion can be clearly shown by a simple experiment with sugar. A lump of ordinary sugar, to which a flame is applied, is not set alight, but gets caramelised, melts and begins to drip. If the sugar is first touched with a minute trace of certain compounds, it is readily lighted and continues to burn with a flame. According to the addition made the size of flame and the character of the carbonaceous residue varies within certain limits. (34) By using tobacco ash this experiment becomes as interesting a study of the catalytically directed scission of the sucrose molecule as it can be made an effective and entertaining parlour trick.

By inference from the behaviour of practically ash-free sugar, and from experimental results in connexion with carbonisation, it becomes manifest that an intimate knowledge of the composition of ash is of paramount importance in all problems connected with the combustion of coal, and many discrepancies observed in the practical utilisation of otherwise similar fuels can be explained by their difference in ash percentage and composition.

THE FUSIBILITY OF COAL ASH.

The problem of the fusibility of coal ash has already attracted the attention of fuel technologists to a considerable extent since liability to partial sintering or fusion causes clinker formation and in consequence the restriction of air supply through fire bars and fuel bed, the envelopment of unburnt fuel in the fused or sintered ash portion and the chemical attack of fire bars and refractories by the resultant corrosive slag, all undesirable phenomena feared by the combustion engineer. They make the determination of the melting and softening point of coal ash a necessary adjunct to the routine tests for the examination of coals.

The principles underlying the softening and melting of ash and the tests for determining the temperatures at which these physical changes take place are the same as those applying to clays and ceramic materials in general. Fusibility depends largely upon chemical composition and in the first instance upon the ratio of alumina to silica which, as in clay, are quantitatively the most important constituents of ordinary coal ash. Accord-

(34) Hedvall, Svensk kemisk Tidskrift, 1920, *32*, 99.

ing to this ratio in any given mixture, the melting point of aluminium silicates or intimate mixtures of pure alumina and silica may vary from 2020°C. for alumina itself down to 1610°C. for the mixture of 13% alumina and 87% silica, rising again for the more silicious mixtures until for pure silica it reaches 1770°C. which is also approximately the melting point of $Al_2O_3,2SiO_2$, alumina and silica in the ratio obtaining in pure clay substance.

On adding bases which act as "fluxes," to an alumina-silica compound or mixture, the melting point is considerably lowered. Richter postulated in 1868 and Bischof confirmed later that molecularly equivalent quantities of the various bases lowered the melting point to the same extent. Their assumption that, on fusing, the aluminium silicate combined with the fluxes to form double silicates, had to give way to the modern physico-chemical conception of solid solutions, according to which as in dilute aqueous solutions an equal number of molecules of different compounds in equal concentration lowers the melting (or solidifying) point to an equal extent.

Of some practical importance in this respect is the difference in slagging effect between iron compounds in various stages of oxidation, for 72 parts of ferrous oxide (FeO) lower the melting point as much as 80 parts of ferric oxide (Fe_2O_3). As iron is one of the main contributors to fusibility the atmosphere in which it is raised to the material temperature is therefore an important factor determining the melting point. Fieldner (35) and his collaborators, who have done a considerable amount of work on the melting point of coal ash, showed that a reducing atmosphere of hydrogen and water vapour, or of carbon monoxide and dioxide gives under suitable conditions melting or softening points as high as those obtained in an oxidising atmosphere. They explain this apparent paradox by the reduction of ferric oxide beyond the ferrous oxide stage to metallic iron (melting point about 1515°C.) but found by analyses of clinkers that reduction in ordinary boiler furnaces is arrested at the ferrous stage, resulting in maximum fusibility. They also found that concordant results could not be obtained in an oxidising atmosphere if small proportions of reducing gases were present, nor in a reducing one, if it contained any oxidising gases.

An interesting point in their valuable researches is that melting points in a CO-CO_2 atmosphere were generally somewhat higher than those obtained in an H_2-H_2O atmosphere. In explanation of this observation I suggest, that in an atmosphere of CO-CO_2, the carbon monoxide is liable to catalytic decomposition into carbon and carbon dioxide and that the carbon either by itself or in form of carbide raises the refractoriness.

The tests used for the determination of the melting points of ash follow the lines of those employed in the testing of refractories. Selvig and Fieldner (36) have standardised a method by which the finely powdered ash is moulded,

(35) U.S. Bur. of Mines. Bull. 129, Bull. 209. Fuel, 1926, 5, 24.
(36) U.S. Bur. of Mines. Bull. 209, 1922.

with the aid of dextrin, into small pyramids similar to Seger cones; these are heated in the reducing atmosphere of a yellow gas flame at a rate of from 5 to 10°C. per minute under specified conditions, and the temperatures of initial deformation, softening and fluidity are observed by means of an optical pyrometer.

Sinnatt, Owles and Simpkin (37) use a test piece in shape of a thread of ash 3/16" long, prepared by extruding a paste with dextrin through a 1/32" orifice, which is mounted on platinum foil and heated in a small tube furnace.

The term melting point so far used does not apply to the heterogeneous mass which coal ash represents. Even the most finely subdivided and homogeneously mixed clay has no definite melting point, but on being gradually heated, passes through softening and fusing stages of varying range. In coal ash as obtained in practical fuel utilisation the conditions are much more complicated on account of the irregular distribution of the ash and its different constituents over the lumps or particles constituting the bulk, and throughout the mass of each individual piece.

Let us imagine for one moment, a mass of coal as charged on the grate of a boiler furnace to be devoid of combustible matter, but to be distributed in space as if the coal substance or its residual portion was still present. In other words, we visualise a combination of ash skeletons like those seen in the stereoscopic examination with the aid of X-rays. On exploring the chemical composition and distribution of these skeletons and their orientation to each other, we would find individual pieces to consist of grey layers of the highly refractory and comparatively dense clay base of durain, alternating with brownish laminae of light, fluffy, alkaline clarain and vitrain ash, separated and crossed by thin veins of calcite or ankerite, with lenticles of similar material mixed with clay, representing the fusain; crystals of pyrites would be found dotted over the whole mass or in form of sheets like the veins of calcite. Fragments of shale or other stone, may adhere to, or be enclosed in, the same pieces. The skeletons representing original pieces would, of course, differ from each other in structure and size, and be packed in an irregular arrangement. Moreover, loose pieces of shale, calcite, gypsum, pyrites or other minerals would be present in their natural state and mixed with the skeletons from the coal proper.

On applying heat to this kaleidoscopic mass of "mineral space lattices," the individual components, having undergone the chemical changes involved in burning off the coal substance, will behave as regards softening or fusion in the first instance as governed by their own composition. Thus, the alkaline portion of the clarain ash skeleton will sinter, or partially melt at fairly low temperatures, causing its own shrinkage and splitting off adjoining laminae of durain. Ferrous sulphide resulting from the decomposition of pyrites (M.P. 1190°C.) and ferrous oxide (M.P. 1419° C.) from ankerite

(37) J. Soc. Chem. Ind., 1923, 42, 266T.

also soften at comparatively low temperatures. Once these metallic compounds approach their sintering stage, they become capable of reacting with others with which they are in contact, particularly with silica, which may be present in the free state or in clay, the products in their turn acting as solvents and slagging agents. The slag thus formed partially or completely envelopes particles of unburned coal substance and prevents further access of air, and thus combustion. The high viscosity of these slags at or even above the temperature of their formation prevents them from running, and, therefore, localises their action, unless an undue proportion of fluxes is present.

The picture presented by the final stage of combustion is that lumps of refractory clay from durain and of shale have retained approximately the shape of their original skeleton ; the surfaces are covered by films of slag where the fusible ashes of clarain and vitrain, pyrites and ankerites had access, whilst nodules or stalactites of slag or glass are formed in places where the latter materials were concentrated.

Whilst thus a slag film of clarain ash or ankerite may not succeed in lowering the fire stability of a lump of durain ash burned to a highly refractory firebrick, an ash of the identical average chemical composition if ground and intimately mixed, would behave in an entirely different manner in that the fluxes would have a more marked effect on the less fusible portions.

This emphasises the importance attached to the study of the distribution of ash in the previous lectures. It must not be inferred that these considerations make the melting point test superfluous ; they merely indicate that the values obtained by it should be used with as much caution as the results from the complete analysis of an averaged sample of coal ash.

Incidentally, it might be stated that the high alumina-silica content of durain is at least one factor apart from the combustible matter which makes coals high in durain suitable for steam raising. Indeed, Constam (38) suggested to add kaolin or quartz to coals having very fusible ashes in order to raise their melting point.

Size of particle is here again of the utmost importance, and as a general rule it may be expected that clinkering is promoted as the size decreases. The dust fired in powdered fuel plants would, therefore, most nearly approach the conditions of the melting point tests where the ash is allowed to collect at a temperature beyond the permitted maximum. For this reason it has been found expedient to provide water-cooled screens against which the hot ash particles impinge and are cooled before the more fusible ones adhere to those of higher refractoriness.

Whilst fusion of ash is generally avoided by the selection of coals or by special precautions, such as steaming, in the "slagging" type of gas producer it is actually induced by the addition of limestone or iron ore to the

(38) J. Gas Lighting, 1913 *124*, 522.

fuel bed, which is kept at very high temperatures. The advantages gained from these producers, which are not used to any extent in this country, are high rate of gasification and hence low capital outlay, avoidance of clinker removal, complete combustion of carbon and the use of coal or coke having low-melting ashes, which would give trouble in other types of producers or furnaces.

PAN ASH CLEANING.

The presence of ash impedes the combustion process to such an extent that in the zones of a fuel bed in which the ash becomes concentrated to the preponderating portion, the residual combustible particles of fuel are not in contact with each other and, therefore, unable to maintain continuity of flame, and remain unburned. Moreover, where such particles are enveloped in molten slag and no longer exposed to the oxygen of the air, their thermal energy also remains unutilised. The fuel thus lost may range from 25 to 50 per cent. of the weight of residue or more.

A number of devices are in use for the purpose of separating the solid fuel residue into loose ash, clinker and unburnt coke. Their construction is based on the difference in specific gravity of the coke and clinker. In some the coke is carried by a current of water, whilst the clinker sinks, various types of screw conveyors or elevators being employed for carrying the separated products out of the apparatus. Lately, machines have been introduced, in which the aid of a clay slip of specific gravity higher than water is invoked as a separating medium.

On the fact that most coal ashes and particularly those liable to clinker formation, contain a fair percentage of iron, is based a system of magnetic separation. The comparatively feeble magnetic properties of ferric oxide and the silicates of iron present in clinker, demand a high magnetic intensity. Ullrich's electro-magnetic separator is specially designed to meet this requirement.

The recovery of the large quantity of combustible matter usually left in the cinders from boiler plants, gas retort generators, locomotive fire boxes and other industrial furnaces is a further proof for the need of a better preparation of the coal before use by the improvement of existing washing or cleaning processes and their application to a greater tonnage of raw coal.

INFLUENCE OF THE INORGANIC CONSTITUENTS ON THE CARBONISING PROCESS.

Ash as Inert Matter.

In carbonisation, as in the combustion of coal, the first and obvious function of the ash is that of a diluting impurity.

In the carbonising process, the mineral matter acts similarly to sand, powdered coke or electrode carbon as used in tests for agglutinating power, or to coke breeze as added to highly swelling coals for the purpose of bursting

the bubbles formed in the "plastic layer." It reduces the strength of coke and causes the production of breeze or ballast, which is always higher in ash than the large coal, as is shown by the following ash percentages taken from an actual oven charge which may be taken as typical:—

	Yield. %	Ash. %
Furnace coke (above 1½")	62.8	9.5
Breeze (1½"-½")	2.9	11.3
Ballast (below ½")	2.9	17.4

A high ash percentage in the coal affects not only the coking process as an inert diluent, but it impairs the quality of the coke to an even greater extent. It has been shown by a number of workers that it involves, by the reduction of the fixed carbon percentage, a corresponding increase of the fuel requirements and a decrease of the rate of throughput of a blast furnace. It also necessitates an additional proportion of limestone in the burden, which in its turn calls for further extra fuel to maintain the higher hearth temperature required to keep the greater amount of slag in molten condition and lower its viscosity.

The heavier limestone charge is needed mainly by the disproportionately higher silica and alumina percentage associated with dirt left in the coal. The distribution of silica and alumina in unwashed and washed coal is shown in the following table:—

TABLE V.

	Unwashed %	Washed %
Ash in coal	18.01	4.92
Dirt ,, ...	20.00	5.00
Total SiO_2 in ash	50.25	34.14
Dirt ,, ,, ...	44.14	18.50
Total SiO_2 in coal	9.05	1.68
Dirt ,, ,, ...	7.95	0.91
Dirt SiO_2 : total SiO_2	87.84	54.18
Total Al_2O_3 in ash	24.54	24.32
Dirt ,, ,, ...	19.71	9.27
Total Al_2O_3 in coal	4.42	1.20
Dirt ,, ,, ...	3.55	0.46
Dirt Al_2O_3 : total Al_2O_3	80.32	38.11

This table proves that by the washing process silica and alumina (and also iron) are reduced at a greater rate than the other ash constituents, and that a more thorough cleaning of coal than is practised to-day would imply a drastic cut in the limestone and fuel requirements of the blast furnace.

This argument applies to gas coke with equal force. For, whilst in its use no limestone is required as a corrective for refractory components, it usually contains more ash than oven coke, and its combustion efficiency is, as far as ash is concerned, and leaving other factors such as structure and carbon modifications out of consideration, considerably impaired. Moreover, the mere fact of its leaving a large incombustible, or, more correctly, unburnt residue, is a considerable drawback in connexion with domestic uses.

The Influence of Ash Composition.

Our lack of knowledge of the chemical reactions which most inorganic compounds in coal undergo during carbonisation; or even of the precise form in which the elements are combined in coal itself, renders a study of their effect on its thermal decomposition extremely difficult. The variety of possible forms of combination has already been pointed out in connexion with the conversion of the mineral matter into ash, under preponderantly oxidising conditions. In the carbonising process severely reducing conditions prevail, and some of the inorganic compounds formed from the mineral matter in coal and present in the coke are necessarily very different.

An interesting example is the behaviour of pyrites, which, as has been shown by Powell(39), is decomposed between 300° and 600°C., according to the equation $FeS_2 = FeS + S$. On cooling even with limited access of air, oxidation of the ferrous sulphide occurs according to the equation :—$4\ FeS + 3\ O_2 = 2\ Fe_2O_3 + 4\ S$. On rapid quenching, however, below the effective temperature of 500°C. this decomposition of ferrous sulphide is not complete, and sulphur combined with iron is left in the coke. This shows the kind of reactions which have to be considered before one can arrive at conclusions as to the behaviour of the inorganic compounds.

Incineration of coal leaves a residue which apart from avoidable minor inclusions of carbonaceous matter is entirely inorganic and ready for examination by the usual methods. The coke residue from carbonisation, on the other hand, contains a large part of the mineral matter firmly embedded in the carbonaceous mass, and disintegration or very fine grinding is required to expose it for direct chemical examination. The results of this examination such as treatment with acids or other reagents is therefore dependent on the size of coke particle.

Some of the changes which inorganic compounds undergo during coking can be traced even after incineration, as is shown by the comparison in Table VI. of the ash of a coal and that of the coke made from it under controlled laboratory conditions at 900°C.

The results show that a considerable portion of the alumina was rendered insoluble in hydrochloric acid during carbonisation, whilst the iron remained

(39) J. Ind. Eng. Chem., 1921, *13*, 33.

TABLE VI.
Yorkshire coking slack.
Clarain-vitrain fraction.

	In coal	In coke
Ash % of coal	2.45	2.41

Analysis of—	Ash from coal %	Ash from coke %
Soluble in Water	1.82	1.62
" " HCl	42.54	35.98
Insoluble in HCl	55.64	62.40
Soluble in HCl (including soluble in water)	%	%
SiO_2	0.36	0.42
Al_2O_3	15.69	9.53
Fe_2O_3	22.99	22.83
CaO	0.90	1.52
MgO	0.30	0.27
Na_2O	1.29	0.98
SO_3	0.21	0.65
	41.74	36.20
Insoluble in HCl		
SiO_2	42.16	43.14
Al_2O_3	10.76	18.16
Fe_2O_3	0.80	1.04
CaO	0.24	0.32
MgO	nil	Trace
	53.96	62.66
Total ash—		
SiO_2	42.52	43.56
Al_2O_3	26.45	27.69
Fe_2O_3	23.79	23.87
CaO	1.14	1.84
MgO	0.30	0.27
Na_2O	1.29	0.98
SO_3	0.21	0.65
	95.70	98.86

unaffected. As the sample was ground to pass a 30 mesh screen and was homogeneously mixed, the question of orientation of the ash components to each other did not arise, that is to say, the iron must be presumed to have been in close enough contact with silica to react with it, but did not do so, whilst the alumina formed an insoluble silicate.

Further work on similar lines is required to furnish proof for or against the hypothesis of a formation of iron silicide and iron carbide during carbonisation, compounds which have been claimed to be responsible for the hardness of coke.

The Catalytic Influence of the Mineral Constituents.

What, in my opinion, may be considered the most important function of mineral matter in the carbonisation and, as has been indicated earlier, in the combustion of coal, is its capacity of directing catalytically the course of thermal decomposition of organic matter. I feel some hesitation in pressing for the recognition of the part which mineral matter in coal as well as retort, oven or furnace material play by acting as catalysts, since my endeavours during the last 12 years to carry conviction into the minds of practical gas engineers and coke oven men have met with disappointing response. The theory propounded in a William Young Memorial Lecture(40) in 1914, that at temperatures at which the molecular bonds of affinity of the coal components are severed and the fragments reach their highest degree of activity, certain inorganic compounds must necessarily exert a catalytic influence on the reactions taking place, was based on general experience with catalysts in reactions similar to those contributing towards the complexity of the carbonising mechanism. Such reactions are: oxidation, reduction, dehydration, scission of molecules, polymerisation, ring formation, hydrogenation and dehydrogenation.

The catalytic effect of inorganic compounds was definitely established in subsequent work(41) on the carbonisation of sugar, cellulose and coal, the results from which are summarised in Tables VII., VIII., and IX.

The experimental conditions, for which the original paper should be consulted, were identical in all cases. The remarkable quantitative variation in the yield of coke, according to the catalyst employed, is equalled, if not surpassed by the extraordinary differences in structure, colour, iridescence, brightness, density and porosity shown by the various coke specimens.

The carbonising results obtained with coal are shown in Table IX.

The differences in yields are no less remarkable than in the case of the practically ash-free and more reactive sugar and cellulose, and the directive influence of the catalysts upon the balance of solid residue and volatile products, is of the utmost importance.

The mechanism of the reactions involved has not yet been explained, but the indications are that the various additions influence thermal decomposition, so as to bring about scission of the molecules at different points, with the result that not only the relative quantities are affected, but that the properties of the products and particularly those of the coke are varied, both as regards

(40) J. Gas Lighting, 1914, *127*, 570.

(41) Lessing and Banks, J. Chem. Soc., 1924, *125*, 2344.

TABLE VII.

Influence of Catalysts on the Carbonisation of Sugar.

Compound added.		Compound formed.		Coke obtained (less "compound formed"). Gms. per 100 gms. of sugar.			
Formula.	Gms. per 100 gms. of sugar.		Gms. per 100 gms. of sugar.	Wet.	Dry.	Diff.	Mean.
H_2SO_4	0.98	—	nil	18.28	18.74	−0.46	18.51
$MgCl_2$	0.95	MgO	0.40	17.89	16.96	+0.93	17.43
$CuSO_4$	1.60	Cu_2S	1.59	19.11	14.82	+4.29	16.97
$\frac{2}{3}Al_2(SO_4)_3$	2.30	Al_2O_3	0.68	19.35	13.67	+5.68	16.51
$AlCl_3$	1.34	Al_2O_3	0.51	17.41	15.51	+1.90	16.46
$\frac{1}{3}Al_2(SO_4)_3$	1.14	Al_2O_3	0.34	16.43	15.78	+0.65	16.11
$3NH_4Cl$	1.61	—	nil	16.90	15.15	+1.75	16.03
$FeCl_3$	1.62	FeO	0.72	17.02	14.44	+2.58	15.73
$\frac{1}{6}Al_2(SO_4)_3$	0.57	Al_2O_3	0.17	15.95	12.11	+3.84	14.03
$FeSO_4$	1.52	FeS	0.88	14.00	12.46	+1.64	13.23
$\frac{1}{2}FeSO_4$	0.76	FeS	0.44	14.99	10.21	+4.78	12.60
$2NaCl$	1.17	Na_2CO_3	1.06	12.42	10.79	+1.63	11.61
NH_4Cl	0.53	—	nil	12.33	10.22	+2.11	11.28
$Ni(NO_3)_2$	1.83	NiO	0.76	10.45	11.77	−1.32	11.11
$2KNO_3$	2.02	K_2CO_3	1.38	—	11.08	?	—
$Cu(OH)_2$	0.98	Cu_2O	1.43	11.41	10.39	+1.02	10.90
$NaHSO_4$	1.20	Na_2SO_4	0.71	9.97	10.94	−0.97	10.46
Na_2SiO_3	1.22	Na_2SiO_3	1.22	11.00	9.90	+1.10	10.45
Na_2CO_3	1.06	Na_2CO_3	1.06	10.18	10.69	−0.51	10.44
K_2CO_3	1.38	K_2CO_3	1.38	9.08	11.19	−2.11	10.14
$2NaOH$	0.80	Na_2CO_3	1.06	10.89	9.17	+1.72	10.03
$NaCl$	0.59	Na_2CO_3	0.53	8.70	10.47	−1.77	9.59
$\frac{1}{2}Al_2O_3$	0.51	Al_2O_3	0.51	9.44	7.45	+1.99	8.45
$MgSO_4$	1.20	MgO	0.40	8.78	7.89	+0.89	8.34
$Al(OH)_3$	0.78	Al_2O_3	0.51	8.09	7.74	+0.35	7.92
$CaCO_3$	1.00	CaO	0.56	8.44	6.92	+1.52	7.88
SiO_2	0.60	SiO_2	0.60	8.26	6.93	+1.33	7.61
$MnSO_4$	1.51	MnO	0.71	8.48	6.76	+1.72	7.61
China clay	2.59	Ign. clay	2.23	8.72	6.16	+2.56	7.44
$(NH_4)_2CO_3$	0.96	—	nil	6.88	7.04	−0.16	6.96
$Fe(OH)_3$	1.07	Fe_2O_3	0.80	8.27	5.53	+2.74	6.90
$\frac{1}{2}Fe_2O_3$	0.80	Fe_2O_3	0.80	7.31	6.40	+0.91	6.85
Untreated	nil	—	nil	6.45	6.48	−0.03	6.46
Na_2SO_4	1.42	Na_2SO_4	1.42	7.11	5.67	+1.44	6.39
FeS	0.88	FeS	0.88	6.07	6.55	−0.48	6.31
$NiCO_3$	1.19	NiO	0.75	7.28	5.26	+2.02	6.27
CaO	0.56	CaO	0.56	6.38	6.11	+0.27	6.25
$\frac{1}{2}(COOH)_2$	0.45	—	nil	5.44	6.44	−1.00	5.94
CuO	0.79	CuO	0.79	6.17	5.35	+0.82	5.76
MgO	0.40	MgO	0.40	5.62	5.26	+0.36	5.44
NiO	0.75	NiO	0.75	5.63	5.02	+0.61	5.33

TABLE VIII.

Influence of Catalysts on the Carbonisation of Cellulose.

Compound added.		Compound formed.		Coke obtained (less "compound formed"). Gms. per 100 gms. of cellulose.			
Formula.	Gms. per 100 gms. of cellulose.		Gms. per 100 gms. of cellulose.	Wet.	Dry.	Diff.	Mean.
H_2SO_4	0.98	—	nil	19.82	20.36	—0.54	20.09
$\frac{2}{3}Al_2(SO_4)_3$	2.30	Al_2O_3	0.68	14.77	15.11	—0.34	14.94
$CuSO_4$	1.60	Cu_2S	1.59	12.68	14.81	—2.13	13.75
$AlCl_3$	1.34	Al_2O_3	0.81	13.07	14.36	—1.29	13.72
$\frac{1}{3}Al_2(SO_4)_3$	1.14	Al_2O_3	0.34	12.80	14.30	—1.50	13.56
Na_2CO_3	1.06	Na_2CO_3	1.06	14.87	12.14	+2.73	13.51
Na_2SiO_3	1.22	Na_2SiO_3	1.22	13.38	13.28	+0.10	13.33
$FeCl_3$	1.62	FeO	0.72	11.78	14.80	—3.02	13.29
2NaOH	0.80	Na_2CO_3	1.06	13.46	12.84	+0.62	13.15
$MgCl_2$	0.95	MgO	0.40	10.83	13.73	—2.90	12.18
NaCl	0.59	Na_2CO_3	0.53	12.21	11.56	+0.65	11.89
$3NH_4Cl$	1.61	—	nil	9.92	13.50	—3.58	11.71
2NaCl	1.17	Na_2CO_3	1.06	12.65	10.64	+2.01	11.65
K_2CO_3	1.38	K_2CO_3	1.38	10.98	11.55	—0.57	11.27
$2KNO_3$	2.02	K_2CO_3	1.38	9.33	12.94	—3.61	11.24
$\frac{1}{2}FeSO_4$	0.76	FeS	0.44	9.64	12.07	—2.43	11.08
$FeSO_4$	1.52	FeS	0.88	9.72	11.92	—2.20	10.82
NH_4Cl	0.53	—	nil	8.44	11.46	—3.02	9.96
$\frac{1}{6}Al_2(SO_4)_3$	0.57	Al_2O_3	0.17	8.37	11.38	—3.01	9.88
CuO	0.79	CuO	0.79	7.79	10.25	—2.46	9.02
$NiCO_3$	1.19	NiO	0.76	8.32	9.50	—1.18	8.91
Na_2SO_4	1.42	Na_2SO_4	1.42	7.75	9.92	—2.17	8.84
$Fe(OH)_3$	1.07	Fe_2O_3	0.80	8.50	9.06	—0.56	8.78
CaO	0.56	CaO	0.56	8.49	9.04	—0.55	8.77
NiO	0.75	NiO	0.76	8.55	8.82	—0.27	8.69
$Al(OH)_3$	0.78	Al_2O_3	0.51	8.11	9.26	—1.15	8.69
$Ni(NO_3)_2$	1.83	NiO	0.76	8.55	7.07	+1.48	7.81
$\frac{1}{2}Fe_2O_3$	0.80	Fe_2O_3	0.80	9.03	6.11	+2.92	7.57
$Cu(OH)_2$	0.98	Cu_2O	1.43	8.49	6.07	+2.42	7.28
$MgSO_4$	1.20	MgO	0.40	6.72	7.80	—1.08	7.26
China clay	2.59	Ign. clay	2.23	7.88	6.51	+1.37	7.20
$\frac{1}{2}Al_2O_3$	0.51	Al_2O_3	0.51	6.92	7.24	—1.32	7.08
$NaHSO_4$	1.20	Na_2SO_4	0.71	5.88	8.19	—2.31	7.04
MgO	0.40	MgO	0.40	5.15	7.74	—2.59	6.99
FeS	0.88	FeS	0.88	7.27	6.51	+0.76	6.89
$MnSO_4$	1.51	MnO	0.71	5.10	8.50	—3.40	6.80
SiO_2	0.60	SiO_2	0.60	6.70	6.85	—0.15	6.78
$(NH_4)_2CO_3$	0.96	—	nil	4.70	8.00	—3.30	6.35
$CaCO_3$	1.00	CaO	0.56	6.20	5.63	+0.57	5.92
Untreated		—	nil	5.60	6.00	—0.40	5.80
$\frac{1}{2}(COOH)_2$	0.45	—	nil	5.23	5.16	+0.07	5.19

TABLE IX.

Influence of Catalysts on the Carbonisation of Coal at 900°.

Clarain and Vitrain from Dalton Main.

Through 30-mesh sieve. HCl-extracted.

	Coke less compd. formed. %	Retort carbon. %	Tar. %	Gas (c.c. per gm.).	Coke + retort carbon. %	Tar + retort carbon %
$FeCl_3$	65.72	1.32	17.59	254	67.04	18.91
H_2SO_4	64.33	1.07	18.15	262	65.40	19.22
$FeSO_4$	64.04	1.94	20.85	256	65.98	22.79
Na_2SiO_3	63.69	1.09	20.12	249	64.78	21.21
Na_2CO_3	63.50	1.74	20.37	245	65.24	22.11
SiO_2	63.34	1.51	21.28	252	64.85	22.79
Al_2O_3	62.92	1.95	22.13	243	64.87	24.08
K_2CO_3	62.77	1.41	21.69	244	64.18	23.10
2NaCl	62.28	1.82	20.76	255	64.10	22.58
$\frac{1}{2}Fe_2O_3$	62.23	3.34	24.05	245	65.57	27.39
CaO	61.08	3.42	20.20	253	64.50	23.62
MgO	60.94	3.57	22.05	248	64.51	25.62
$(COONa)_2$	59.92	3.69	19.73	258	63.61	23.42
Na_2SO_4	57.62	5.34	26.17	269	62.96	31.51
Untreated	53.68	8.48	29.02	255	62.16	37.50

chemical composition and physical character. Support has been given to the latter contention by more recent work(42) on similar lines, in which the coke obtained was analysed for its ultimate composition. As will be seen from some typical examples recorded in Table X. this varies very considerably.

TABLE X.

Ultimate analysis of cokes.

Compound added	Carbonised at 600° $Al_2(SO_4)_3$		Untreated	Carbonised at 900° $FeCl_3$		Untreated	
C	85.60	..	83.03	89.96	..	87.82	% of coke
H	3.25	..	2.90	1.24	..	1.24	,, ,,
Ash ..	2.98	..	2.41	3.99	..	2.87	,, ,,
O+S+N ..	8.17	..	11.66	4.81	..	8.07	,, ,,
	100.00		100.00	100.00		100.00	% of coke

The differences are still more interesting when expressed in percentage yields of carbon, hydrogen and oxygen, and referred to the original coal, as shown in Table XI.

(42) J. Soc. Chem. Ind., 1925, *44*, 345.

TABLE XI.

Carbonised at 600°

Compound added	Coke	Coke, less compound formed	Carbon in coke	Hydrogen in coke	O+S+N in coke.	
$Al_2(SO_4)_3$	75.48	74.79	64.60	2.45	6.17	% of coal.
Untreated	69.71	69.71	57.80	2.02	8.13	,, ,,

Carbonised at 900°

Compound added	Coke	Coke, less compound formed	Carbon in coke	Hydrogen in coke	O+S+N in coke	
$FeCl_3$	65.38	64.68	58.82	0.81	3.14	% of coal.
Untreated	62.27	62.27	54.69	0.77	5.03	,, ,,

The results indicate that catalysts which increase the coke yield also tend to raise the carbon percentage in the coke obtained. A surprising result is that the oxygen content in the cokes, after making allowance for the possible total of sulphur and nitrogen included in the difference values, varies very considerably, a fact which has an important bearing on the inflammability, reactivity and combustibility of coke.

Recently some work has been done by others (43) on the influence on carbonisation, of inorganic compounds added to coal or of the composition of its ash, and the fact that such compounds have a decisive effect on the yield, distribution and properties of the products, both in the primary decomposition of the coal and the secondary changes of the first products, can no longer be doubted.

INFLUENCE ON GASIFICATION OF COAL AND COKE IN PRODUCERS.

The influence of catalysts is not restricted to the purely thermal decomposition of coal at high or low temperature. It applies to the combustion process whether carried out to completion, as in industrial or commercial heating practice, or in the form of partial combustion in gas producers. In water gas and power gas making the addition of such substances as lime or iron ore has long been practised for the purpose of increasing the ammonia yield or influencing the water gas equilibrium or the composition of the final gas. Moreover, as has been said, the chemical and physical properties of the coke used in these processes depend on the amount and composition of the ash, which, therefore, predetermine the rate of gasification obtainable with different qualities.

(43) Baehr, Stahl und Eisen, 1924, *44*, 1, 39.
Koppers, Stahl und Eisen, 1924, *44*, 691.
Marson and Cobb, Gas J., 1925, *171*, 39.
Kreulen, Chem. Weekblad, 1923, *20*, 553; 1924, *21*, 58; 1925, *22*, 476.

INFLUENCE ON HYDROGENATION AND TOTAL CONVERSION INTO OILS.

The direct liquefaction of coal and semi-coke by hydrogenation under pressure has attained a considerable degree of scientific interest, if not commercial importance. In the process as proposed and practised by Bergius, a certain amount of iron oxide is usually added to the coal charged into the autoclave, ostensibly for the purpose of binding sulphur. Bergius (44) recognises that the inorganic constituents have an influence on the liquefaction of coal, and he points out that for their study, which in Germany had not yet received any considerable attention, the solid residue from hydrogenation will be of particular interest, as it consists to a large extent, and sometimes exclusively, of the mineral compounds in their original state and unaffected by high temperature reactions.

Whilst Bergius does not regard the catalytic influence of inorganic substances as of practical importance, a number of other workers found that certain compounds may exert a profound catalytic effect upon hydrogenation of coal under high pressure, as, indeed, they do in the hydrogenation of fatty oils and hydrocarbons. Fischer (45) found that hydrogen without catalyst gave much poorer results than hydrogen in the presence of sodium carbonate. Recently, Graham (46) studied the effect of a high ash content on the hydrogenation of lignite. The work of Fierz-David (47) and of Bowen, Shatwell and Nash (48) on the liquefaction of cellulose and coal proved conclusively that the hydrogenation and thermal decomposition at low temperatures of cellulose is subject to very considerable catalytic influence.

The synthesis of liquid hydrocarbons and alcohols from water gas as carried out by the Badische Company and as suggested in Fischer's Synthol process is, of course, entirely based on catalysis and in the manufacture of the water gas used as raw material, the composition of the coke ash or its adjustment are of vital importance in determining the composition and efficiency of production of the gas.

THE CLEAN COAL OF THE FUTURE.

In the opening sentences of my first lecture, I warned my audience that the portion of the subject on which I had been asked to speak, dealing with clean coal, would take up only a fraction of the allotted time. Coal, as we know and use it, with negligible exceptions, must be regarded as a mixture of the true fuel containing its unavoidable complement of inherent ash, with extraneous incombustible matter. The bearing of the mineral matter on the economics of coal utilisation has already been illustrated

(44) Z. Ver. Deutsch. Ing., 1925, *69*, 1313, 1359.
(45) Fischer-Lessing, " The Conversion of Coal into Oils," page 197.
(46) Fuel, 1925, *5*, 484.
(47) J. Soc. Chem. Ind., 1925, *44*, 942R.
(48) J. Soc. Chem. Ind., 1925, *44*, 507T.

by an example dealing with the cost of its transport. To visualise the ash problem in the carbonising industries, which practise fuel economy probably more than any other, another illustration may be given.

I have pointed out before (49) that the coking industry in this country is burdened with a dead weight of ash, amounting in 1924 to about 1,275,000 tons and requiring for its accommodation and heating the equivalent of 1,200 coke ovens. In the gas industry where coals of rather higher ash percentage are used, a total throughput of mineral matter of about 1,800,000 tons per annum must be assumed. This implies that little less than the equivalent of the carbonising capacity of the Gas Light and Coke Company is constantly employed and a corresponding amount of retort fuel is wasted, in the useless heating of inert matter which eventually forms the least desirable constituent of ordinary gas coke.

To these economic shortcomings must be added the technical disadvantages of a high or even what is to-day a normal ash percentage. It is now an accepted fact that at least some ash constituents have a detrimental effect on the processes of coal utilisation. As long as coal is used containing mineral matter, the nature of which is not known, the working results are influenced by this unknown, but in many cases decisive factor.

In order to give the directing mind of the modern fuel technologist full scope, he must have supplied to him a coal containing a minimum of extraneous matter so that the working results are not left to the uncontrollable effects of these chance impurities, but are subject to tolerably exact prediction, possibly involving calculated and predetermined additions of necessary correctives.

Though it is never safe to prophesy, I make bold to suggest that within very few years the carbonising industries, which are mainly concerned in the efficient recovery of the intrinsic value of coal, will feel constrained to insist for their raw material on coal containing only a fraction of the proportion of mineral matter which is customary to-day. I further believe that the provision of such a commodity will be technically possible and commercially profitable, and that it will be of economic advantage both to supplier and user.

I fear that in endeavouring to survey the branch of coal research and fuel practice dealing with its mineral associates, I was forced by the exigencies of time to present a sketch rather than a detailed exposition of the subject. The difficulty of adequately dealing in the space of a few hours with all phases of the problem of coal ash proves the extent to which it affects the whole fuel question. The subject has not received in the past, and hardly receives to-day, the attention which its importance justifies. As an example of this neglect may be cited that at the recent conference on smokeless fuels, held at Sheffield, not one of those who contributed to the discussion

(49) J. Soc. Chem. Ind., 1925, *44*, 345T.

deemed the influence of ash constituents on the carbonising mechanism worthy of mention. Yet I am convinced that some of the results already obtained, for instance, on the catalytic behaviour of inorganic compounds, are sufficiently definite to show that a great deal of the research work on the carbonisation of coal and other fuels is subject to considerable revision, as in most of this work the influence of the composition of the mineral matter, apart from its amount, was not considered. I hope to have convinced you that a close study of the valueless portion of coal is one of the urgent needs of fuel research and that the results likely to be obtained from it will be of help in enhancing the value of our most vital source of energy—coal.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 p.m. :—

February 3.—Sir Edward John Russell, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station, "Investigations in Agricultural Science at Rothamsted." The Right Hon. Lord Clinton, Chairman, Lawes Agricultural Trust, in the Chair.

February 10.—Professor J. C. Drummond, D.Sc., F.I.C., Professor of Bio-Chemistry, University College, London. "Modern Views of Vitamins." Charles James Martin, C.M.G., M.B., D.Sc., F.R.S., Director, Lister Institute of Preventive Medicine, in the Chair.

February 17.—James Edward Taylor, M.I.E.E., Superintending Engineer, Post Office Telegraphs, etc., South Midland District, "The Propagation of Electric Waves." Admiral of the Fleet Sir Henry Jackson, K.C.B., F.R.S., in the Chair.

February 24.—Mrs. Mary Fishenden, Fuel Research Board, "Domestic Heating."

March 3.—Percy Dunsheath, O.B.E., M.A., B.Sc., M.I.E.E., Chief of Research Department, W. T. Henley's Telegraph Works Co., Ltd., "Science in the Cable Industry." Llewellyn B. Atkinson, M.I.E.E., in the Chair.

March 10.—Reinhardt Thiessen, Ph.D., of the Bureau of Mines (U.S. Department of the Interior), "The Microstructure of Coal."

March 17.—Lieut.-Colonel John Herbert Boraston, C.B., C.B.E., "Co-Partnership."

Indian Section.

Friday afternoons, at 4.30 o'clock.

February 19.—Sir Michael F. O'Dwyer, G.C.I.E., K.C.S.I., "Religions and Races in the Punjab." (Sir George Birdwood Memorial Lecture.) The Right Hon. the Earl of Ronaldshay, G.C.S.I., G.C.I.E., late Governor of Bengal, in the Chair.

March 19.—Lady Chatterjee, "Women and Children in Indian Industries."

April 16, May 14.

Dates to be hereafter announced :—

Herbert Baker, A.R.A., F.R.I.B.A., "The New Delhi."

Joseph Charles French, I.C.S., "Buddhistic Art in Bengal."

DOMINIONS AND COLONIES SECTION.

MARCH 2.—SIR BASIL CLARKE, Managing Director, Editorial Services, Ltd., late Director Publicity Ministry of Reconstruction, Ministry of Health, and Irish Office, etc., "Publicity in relation to the Problems of Empire Settlement and Trade."

APRIL —.—SENOR BOLIN, "Spanish North Africa." HIS EXCELLENCY THE MARQUES MERRY DEL VAL, Spanish Ambassador, in the Chair.

TUESDAY, MAY 4.—CHARLES PONSONBY, Managing Director, British Central Africa Company, "Nyasaland." BRIGADIER-GENERAL SIR S. H. WILSON, K.C.M.G., K.B.E.. C.B., Permanent Under-Secretary of State for the Colonies, in the Chair.

INDIAN AND DOMINIONS AND COLONIES SECTIONS (JOINT MEETING).

SIR RICHARD REDMAYNE, K.C.B., M.I.M.E., F.G.S., "The Work of the Imperial Institute."

CANTOR LECTURES.

Monday evenings at 8 o'clock.

H. P. SHAPLAND, A.R.I.B.A., Editor of the *Cabinetmaker*, "The Decoration of Furniture." Three Lectures. January 18, 25 and February 1.

LECTURE III.—Lacquering. Preparation of the gum method of application. Damp presses for drying. Prolonged treatment of fine lacquer. European lacquer. The decoration of furniture by the application of leather, needlework, velvet and other textiles. Overlaying with ivory, precious metals and tortoiseshell. The enrichment of Cypress chests. Gesso work. Composition ornament. Sevres and Wedgwood plaques.

G. W. C. KAYE, O.B.E., M.A., D.Sc., Superintendent, Physics Department, National Physical Laboratory, "The Production and Measurement of High Vacua." Three Lectures. February 15, 22, and March 1.

W. F. HIGGINS, M.Sc., National Physical Laboratory, "Thermometry." Three Lectures. March 15, 22, and 29.

CHARLES REED PEERS, C.B.E., M.A., Director S.A., Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." Three Lectures. April 19, 26, and May 3.

For Syllabus see *Journal*, January 8.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 1..Architects, Royal Institute of British, 9, Conduit Street, W. 8.30 p.m. President's Address to Students.

Civil Engineers of Ireland, Institution of, 35, Dawson Street, Dublin. 8 p.m.

Farmers' Club, at 12, Great George Street, S.W. 4 p.m. Mr. H. B. Turner, "The Drainage of Heavy Land."

Electrical Engineers, at Merchant Venturers' Technical College, Bristol. 6 p.m.

Société Internationale de Philologie, Sciences et Beaux-Arts. 3.30 p.m. The Very Rev. Father Berenger, "Ceylon and its Ruined Cities."

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Transport, Institute of, at Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Sir John E. Eaglesome, "Roadless Traction."
At Town Hall, Leeds. 5.30 p.m.

Chemical Industry, Society of, at Institution of Mechanical Engineers, Storeys Gate, S.W. 8 p.m. Mr. Francis H. Carr, "The Training of Chemists for Industry."

Engineers, Society of, Burlington House, W. 5.30 p.m. Mr. G. O. Case, Presidential Address.

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Otakar Vocadlo, "Some Aspects of Czechoslovakia." (Lecture III.)
5.30 p.m. Baron A. F. Meyendorff, "Tendencies and Types of Agrarian Legislation in Eastern Europe." (Lecture I.)

At University College, Gower Street, W.C. 4.30 p.m. Mr. Henry Higgs, "Some Social Problems in the Light of Economics and Statistics." (Lecture III.)
5.30 p.m. Mr. M. H. Krishna, "Indian Archæology and Anthropology." (Lecture III.)
5.15 p.m. Dr. R. W. Lunt, "The Chemistry of Ionization by Collision." (Lecture I.)
At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture I.)
At King's College, Strand, W.C. 5.30 p.m. Prof. Gaetano Salvemini, "The Political Evolution of Italy in the Nineteenth Century." (Lecture I.)
At 5.30 p.m. Dr. F. A. P. Aveling, "The Human Will." (Lecture III.)
At University College, Gower Street, W.C. 5.30 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture III.)
At King's College, Strand, W.C. 4 p.m. Prof. A. V. Hill, F.R.S., "The Physiology of Muscle." (Lecture I.)

TUESDAY, FEBRUARY 2.. Automobile Engineers, Institution of, at ROYAL SOCIETY OF ARTS, Adelphi, W.C

Electrical Engineers, Institution of, at 17, Albert Square, Manchester. 7 p.m. Mr. E. V. Clark, "Power Factor and Tariff." Mr. E. W. Dorey, "Power Factor Improvement."

Marine Engineers, Institute of, 85, The Minories, E. 6.30 p.m. Mr. Stanley S. Cook, "High Efficiency Steam Installations for Ship Propulsion."

Oneirological Society, 8, Taviton Street, Gordon Square, W.C. 3.30 p.m. Dr. J. Barker Smith, "The Problem of Sleep."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Pictorial Group Meeting.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. Eric K. Rideal, "Surface Action."

University of London, at the London School of Economics, Aldwych, W.C. 5 p.m. Dr. T. E. Gregory, "Adam Smith as a Currency Theorist."
At University College, Gower Street, W.C. 5.30 p.m. Miss M. A. Murray, "Primitive Cults in Ancient Egypt."
5.30 p.m. Dr. E. G. Richardson, "Acoustics of Buildings." (Lecture III.)
At the Institute of Historical Research, Malet Street, W.C. 4 p.m. Prof. Janko Lavrin, "Slovene Literature." (Lecture I.)
At King's College, Strand, W.C. 5.30 p.m. Miss H. D. Oakeley, "Philosophy and History." (Lecture I.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture III.)

WEDNESDAY, FEBRUARY 3.. Archæological Institute, Burlington House, W. 5 p.m. Mr. A. W. Chapman, "Carolingian Architecture in England." Entomological Society, 41, Queen's Gate, S.W. 8 p.m.

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr J. Hollingworth, "The Propagation of Electric Waves."

Geological Society, Burlington House, W. 5.30 p.m. Prof. Dr. S. J. Shand, "The Alkaline Rocks and Ring-Intrusions of Pilansberg (Transvaal)."

Public Analysts, Society of, Burlington House, W. 8 p.m. Dr. L. H. Lampitt and Mr. E. B. Hughes, "The Determination of Copper in Vegetables," Dr. H. E. Cox, "Arsenic in Apples." Mr. A. J. Berry, "The Titration of Thallous Salts by Potassium Iodate." Mr. C. H. Wright, "The Hot Springs at Nasavusavu."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Mr. B. M. Headicar, "The London School of Economics Library, its Work and Methods."
At King's College, Strand, W.C. 5.30 p.m. Sir Richard Lodge, "Sir Robert Peel."
5.30 p.m. Miss Asta M. Kihlbom, "Verner von Heidenstam."
3 p.m. Prof. E. G. Gardner, "The Purgatorio of Dante." (Lecture III.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Earliest Civilisation of the Slavs." (Lecture III.)

THURSDAY, FEBRUARY 4.. Aeronautical Society, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7 p.m. Mr. C. L. Lawrance, "American Aircraft Engine Development." (Joint Meeting with Institution of Automobile Engineers.)

Child Study Society, at 90, Buckingham Palace Road, S.W. 6 p.m. Miss Lena Ashwell, "The Drama and Education."

Chemical Society, Burlington House, W. 8 p.m. Mr. F. G. Mann and Sir William J. Pope, "The Complex Salts of $\beta\beta'\beta''$-Triaminotriethylamine with Nickel and Palladium." Mr. F. G. Mann and Sir William J. Pope, "$\gamma\gamma'\gamma''$-Triaminotripropylamine and its Complex Compounds with Nickel." Mr. P. L. Robinson and Mr. H. C. Smith, "A Comparison of the Atomic Weight of Silicon from different Sources."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. E. V. Clark, "Power Factor and Tariff." Mr. E. W. Dorey, "Power Factor Improvement."

Linnean Society, Burlington House, W. 5 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. J. L. Myres, "Who were the Greeks."

Royal Society, Burlington House, W. 4.30 p.m.

Structural Engineers, Institution of, at 296, Vauxhall Bridge Road, S.W. 7.30 p.m. Mr. W. J. H. Leverton, "The Aesthetic Treatment of Concrete."

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Miss Joan Evans, "The Development of Jewels."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Prof. Edmund G. Gardner, "The Florentine Academies in the Renaissance."
At the London School of Economics, Aldwych, W.C. 5.30 p.m. Dr. W. C. Dickinson, "Scotland—The Making of the Kingdom."
At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Customary Law in Europe." (Lecture II.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk-Mirsky, "Early Russian Literature." (Lecture IV.)
4 p.m. Mr. I. L. Evans, "Economic Development of South-Eastern Europe." (Lecture I.)
At King's College, Strand, W.C. 5 p.m. Dr. J. A. Hewitt, "Metabolism of Carbohydrate and Fat." (Lecture III.)

FRIDAY, FEBRUARY 5.. Geologists' Association. 7.30 p.m. Mr. H. Dewey, Presidential Address, "Studies in Danish Geology."
Société Internationale de Philologie, Sciences et Beaux-Arts, 8, Taviton Street, W.C. 8.15 p.m. Mr. J. Campbell, "Life and Works of Samuel Lever."

Photographic Society, 35, Russell Square, W.C. 7 p.m Mr. S. L. Eavestaff, "Thoughts which Occur to me."

Philological Society, at University College, Gower Street, W.C. 8 p.m. Prof. E. Weekley, "Etymological Notes."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. G. Gordon, "Shakespeare's English."

University of London, At University College, Gower Street, W.C. 5.30 p.m. Miss Eleanor Hull, "Ireland from the Earliest Times." (Lecture III.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Making of Modern Roumania." (Lecture I.)

SATURDAY, FEBRUARY 6.. L.C.C. Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. W. J. Perry, "The Quest for Gold and Pearls in Ancient Times."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Walford Davies, "The Triad and the Perfect Fourth."

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JOURNAL

OF THE

ROYAL SOCIETY OF ARTS

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// JOURNAL OF THE ROYAL SOCIETY OF ARTS

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FRIDAY, FEBRUARY 5th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, FEBRUARY 10th, at 8 p.m. (Ordinary Meeting.) PROFESSOR J. C. DRUMMOND, D.Sc., F.I.C., Professor of Bio-Chemistry, University College, London, "Modern Views of Vitamins." CHARLES JAMES MARTIN, C.M.G., D.Sc., LL.D., D.C.L., F.R.S., Director Lister Institute of Preventive Medicine, will preside.

CANTOR LECTURE.

MONDAY, JANUARY 25th, 1926. MR. H. P. SHAPLAND, A.R.I.B.A., delivered the second of his course of three lectures on "The Decoration of Furniture."

The lectures will be published in the *Journal* during the Summer recess.

SEVENTH ORDINARY MEETING.

WEDNESDAY, JANUARY 27th, 1926. SIR HALFORD JOHN MACKINDER, Chairman of the Imperial Shipping and Imperial Economic Committees, in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

General Sir Edmund G. Barrow, G.C.B., G.C.S.I., London.
Charles Menten Benjamin, London.
Professor P. G. H. Boswell, O.B.E., D.Sc., Liverpool.
Warre Squire Leith Bradley, London.
Hugh W. Brady, Ranchi, India.
R. Douglas Burt, Walsall, Staffs.
H. E. Sir Spencer Harcourt Butler, G.C.I.E., K.C.S.I., D.Litt., LL.D., Governor's Camp, Burma.
Charles Francis Dingman, Palmer, Mass., U.S.A.
Sir Thomas Morison Legge, C.B.E., M.D., London.
Ernest Campbell Mark, B.Eng., Ewell, Surrey.

Frank H. Metcalf, Holyoke, Mass., U.S.A.
Richard Nicholson, Preston, Lancs.
Thomas James Simpson, Port Elizabeth, South Africa.
R. A. Weatherell, London.

The following candidates were duly elected Fellows of the Society :—

Captain Quentin Charles Alexander Craufurd, R.N., Lydd, Kent.
Professor William Frecheville, A.R.S.M., London.
George William Edward Gibson, Hatch End, Middlesex.
F. Maclure Sclanders, Saint John, New Brunswick, Canada.
W. Turnbull, Ramsbottom, Manchester.

A paper on "Some General Problems of the Transport by Sea and Conservation in Store of Ripe Fruit" (Aldred Lecture) was read by PROFESSOR JOHN McLEAN THOMPSON, D.Sc., F.R.S.E., Professor of Botany, University of Liverpool.

The paper and discussion will be published in the *Journal* dated February 26th.

BINDING COVERS FOR JOURNALS.

For the convenience of Fellows and others wishing to bind their annual volumes of the *Journal*, cloth covers can be supplied, post free, for 2s. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, JANUARY 5TH, 1926.

THE RT. HON. SIR FREDERICK LUGARD, G.C.M.G., C.B., D.S.O., Commandeur de la Légion d'Honneur, late Governor-General of Nigeria, in the Chair.

THE CHAIRMAN said he was privileged to introduce that afternoon M. Davray, who would address the meeting on the subject of France's progress in North Africa. Everyone had been reading lately about the Riff campaign, and attention had been to a great extent concentrated on that part of the world; in fact, it had in the past been occasionally too interesting. It would be remembered that some few years ago, at the time of the Treaty of Algeciras and the Agadir crisis it was very much feared that the trouble might lead to a European war. The net result of that crisis, he thought, was to draw France and England closer together.

In introducing M. Davray, he wished to emphasize the part that M. Davray had borne in interpreting the two nations to each other. As translator of several English books into French, as Hon. Secretary of the Anglo-French Society, as a journalist writing on English subjects for French papers and on French subjects for English papers, and as an author of many French books, he had done a great deal to explain to his countrymen the characteristics of the English nation. M. Davray was especially qualified to speak of Northern Africa as he was for some time the correspondent of the *Daily Telegraph* in that part of the world, and had resided in the country for a long time and studied its history.

The paper read was :—

FRANCE IN NORTH AFRICA.

By HENRY D. DAVRAY, C.B.E., Chevalier de la Légion d'Honneur, late Correspondent of the "Daily Telegraph" in North Africa.

It is ninety-five years since France took Algiers and made herself a footing in North Africa.

It is forty-five years since, with the consent of the Sovereign, she established her protectorate over Tunisia.

It is thirteen years since Morocco was placed under her protection by the ratification of agreements and treaties.

The Government-General of Algeria is already making its preparations for the celebration, in 1930, of the centenary of the conquest, and I should like to show you rapidly what France has accomplished during this period in a country of an area several times larger than her own.

I think it will be as well to make certain preliminary remarks. For when we have clearly grasped the situation of affairs at the beginning of the story, we shall be in a better position to understand its later developments.

In 1830, Charles X was the reigning monarch. He had, a few years previously, succeeded Louis XVIII, replaced on the throne by the Allies after they had banished Napoleon to St. Helena.

France was enjoying a period of calm after the Revolution and the subsequent twenty years of war. She had no more colonies. In the reign of Louis XV, she had lost India, Canada and Louisiana. All that remained of her possessions of the opening XVIIIth century were a few islands and a few strips of mainland. But—and this is an important point—she felt no need to create colonial outlets. She had no excess of population to establish in new countries. She was her own consumer and disposed of her products to immediate neighbours. She had not yet entered on the phase of industrial activity which was to result from the employment of steam and the working of the coal mines. She had still no railways, no steamboats. None of the great discoveries of the XIXth century had as yet been realised or even dreamt of. The candle was still used for lighting, the horse for transport, but those prodigious changes were about to materialise that make of our epoch an era of history, for which we shall soon have to find an adequate name.

It was at this moment that the Dey of Algiers committed an act of violence against the French Consul. The insult was of such a nature that it could not be passed over without the loss of all prestige from end to end of the Barbary States, in which France has had interests since the XIVth century.

A repressive expedition was decided on. In notifying it to the European Powers, the French Government stated what were her aims and intentions in undertaking it. The Barbary pirates had infested the sea for centuries and the insolence of the native chieftains had passed all limits. France therefore,

set herself the task of "abolishing slavery and piracy, re-establishing the security of navigation in the Mediterranean and opening up its southern coasts anew to agriculture, civilisation, commerce and the free access of all the nations......"

Let us see how this programme has been carried out.

The Expeditionary Force landed and was attacked by the Dey's troops whom it put to rout. After a few days the Sovereign capitulated and the French took possession of Algiers.

Such a prompt solution of the problem was expected by no one. The reign of disorder began. No historian would be believed who described the wild spectacle. If there are people disposed to accuse France of dark schemes and imperialistic designs, let them study these events in detail. If there was a conspiracy it was an extremely badly hatched one. But it was something much more like an adventure than a conspiracy.

At any rate, the echoes of these events have not yet died away. They were followed by consequences of which nobody at that time seems to have had the slightest inkling. From all which it appears that chance sometimes gives better results than the most cleverly combined intrigues.

As soon as the French troops were in the town, it became evident that nothing had been arranged. You can only believe that the authorities who had set the Expedition on foot had never supposed that it might be victorious. Let us read the "Convention passed between the General commanding the French Army and His Highness the Dey of Algiers." There is not very much of the arrogant victor in it.

The first article stipulates for the surrender to the French troops of the Casbah, the other forts and the gates of the town.

By the second, "the General of the French Army engages to leave His Highness the Dey of Algiers in free possession of all his personal wealth."

The third article declares "the Dey shall be free to withdraw with his family and personal riches to the place that he shall choose; and as long as he remains at Algiers, he and all his family will be under the protection of the General of the French Army; guards will assure the safety of his person and the persons of his family."

By article 4 "the same advantages and protection are assured to all members of the Militia."

And now for the full text of Article 5: "The exercise of the Mahommedan religion shall continue to be free. The liberty of all classes of inhabitants, their religion, their properties, their commerce and their industry shall suffer from no interference. The General in command engages himself to this on his honour."

That was all. Let us admit that, everything considered, it was not too bad. The French General appeared to be exercised by the wish to treat the conquered with chivalrous generosity and to exclude all idea of stipulating for some tangible prize of victory.

But this noble disinterestedness did nothing to solve the difficulties which arose at once and got more and more complicated as time went on.

Having, so to speak, no more colonies, France possessed no experienced Colonial staff. She had no ideas on methods to be employed. So it fell out that the soldiers assumed special powers for guaranteeing the security of the town, repelling attacks by the native tribes and enlarging the limits of the zone of defence.

As for the civil administration, it was at once plunged into confusion. The Dey and his high officials had been shipped off to the Orient. Without them any administrative structure that existed collapsed. When it was judged advisable to re-instate the public services, the simple course was taken of treating Algiers like a French sub-prefecture. The inhabitants were submitted to an organisation which was not in the slightest degree meant for them, was entirely incomprehensible to them and could not be adapted to their customs, moral codes or creeds. There was nothing in all this that worked for the organising of the newly conquered country on a basis of order.

We have to take account, too, of another historical circumstance of high importance.

While these events were transpiring on the southern shores of the Mediterranean the July Revolution broke out in Paris and King Charles X was succeeded by Louis Philippe, a constitutional monarch. Now when one government as the result of violent upheavals takes the place of another, it feels it necessary to act differently from its predecessor and rarely accepts with good will the heritage it comes into or at any rate the responsibilities that that heritage entails.

It is not surprising then that the new Government displayed no enthusiasm for the Algiers Expedition which had been left on its hands. Indeed it soon found the Expedition a source of great embarrassment, for the Parliamentary Opposition were quick to seize upon it as a motive for incessant attacks on the Ministry.

At Algiers itself everything seemed to go wrong. The army and the civilians were soon at daggers drawn: this dissension between the two authorities had its echo at Paris and for many years was the cause of constant scandals. Moreover war had to be waged on the native races, insurrections had to be quelled, and there was the long struggle with Abd-el-Kader who had the support of the Sultan of Morocco and was a most redoubtable enemy.

But we need not now go into details. The establishment of the French in Algeria was a difficult, arduous, costly and very unpopular task. At many different times, the trend of public opinion was towards evacuation and it is a strange contradiction, to say the least of it, to find among the partisans of evacuation certain of the military leaders who had played a glorious part in the conquest and in the repression of the rebellions. A tag which became a popular slogan "Nothing prospers in Algiers but the cemeteries," was set going by a General who had passed his whole career there.

In short, if France established herself in Algiers quite unexpectedly on her own part, without any anticipation of the event, " inadvertently," as Professor Gautier said ironically, she seems to have stayed there in spite of herself. The most astonishing thing indeed is that she has stayed there at all.

Still the new colony was not delivered over entirely to the reign of disorder and incompetence. The greater part of the military leaders and the civil authorities were indeed profoundly ignorant about the conquered races and the needs of the country. Some however gave proof of insight and common sense.

From 1833 onward, General Clauzel, for example, who was Commander-in-Chief in Algeria, divined with remarkably clear foresight all the possibilities offered by the conquest of Algiers. He entered into relations with the Cherifian Government at Fez, drafted a treaty with the Bey of Tunis, and was inspired by no less an ambition than to make the French protectorate willingly accepted from one end of North Africa to the other.

But when he informed the Paris Government of his plans and projects, there was mighty commotion. The Cabinet was horrified by the idea that it might come to the ears of Parliament. The unfortunate General was immediately classed as a dangerous individual, subversive of order. In his innocence he returned to the charge and explained that it was no question of a military conquest, but of establishing the French supremacy over the whole of the Moghreb by a series of arrangements and freely accepted conventions. He pointed out that by this means the pretexts for hostility would not be augmented but on the contrary greatly diminished and that French influence, working for peace, would be welcomed by the native inhabitants, comprehending as they must do all the advantages offered to them.

All was in vain. The ministers took fright. They decided that General Clauzel was a megalomaniac, and, to render him harmless, they withdrew from him and brought home half his troops, and the General, profoundly disheartened, was not long in coming back to France himself.

We could pile up examples of this kind of thing. They abound in the history of the conquest of Algeria. The " anti-colonial " Opposition did not spare the famous Marshal Bugeaud any more than General Clauzel. But the Marshal was an excellent administrator as well as a great soldier and he pleaded the cause of Algeria with so much good sense and sagacity that he got the better of his most obstinate opponents.

But I must now come to our own day, bear witness to what I have myself seen, and share with you the knowledge that I have acquired on my travels.

Algeria, Tunisia and Morocco are the names of three provinces which after all are similar from the geological and geographical points of view and are inhabited by populations of the same origin and religion. The same mountain range of Atlas runs west and east, from Agadir and Mogador to Tunis and Carthage. From Tangiers to Bizerta you have the same coast, devoid of natural harbours and composed of high cliffs rising perpendicularly from the sea.

The territories bordering the coast are all fertile in the same degree. The average rainfall is equal, at certain points superior, to that of France. This is a point to which I shall have to return. It is of capital importance and has long been recognised as such, though it is only two or three years that it has formed the basis of a methodical and practical system.

Under these three names then we have an immense country that there is an ever more frequent tendency to call by the collective title of North Africa. Certain people, deputies and senators, journalists and Europeans settled in the country, go so far as to demand a single administration for the three countries, with a Governor-General of North Africa at its head. This appears simple and logical at first sight and appeals directly to the French spirit. But numerous and grave difficulties stand in the way of its practical realisation.

France, as we have seen, set foot in North Africa in 1830. But she did not extend her dominion over Algeria at one stroke. It was not till 1857 that Kabylia made its definite submission. The region that extends beyond the High Plateaux up to the Sahara remained unexplored and those of our columns that occasionally scoured it were frequently attacked.

It was in 1882 that the oases of M'zab was annexed. El Golea has been occupied by a permanent garrison since 1891.

The occupation of the Southern Oases was prepared by M. Jules Cambon, brother of the much-regretted French Ambassador in London and at this moment president of the Ambassadors' Conference. The Oases comprise 400 fortified towns or villages with a population of 50,000 souls. The plans of the Governor-General were long hampered by the Opposition of the General Staff of the XIXth Army Corps. At that epoch, now thirty years ago, the Governor General, who in theory possessed absolute power, had in reality no control over the military authority. The General commanding the African Army entertained no official relations with him and knew nothing of the vast problems that the Governor-General had to solve. This is another example of the lamentable antagonism between the military and civil authorities that has cost Algeria so dear ever since the first days of the conquest. This unfortunate state of things was ended by a decree of 1901.

When he was called to the post of Ambassador at Washington, M. Jules Cambon had not yet been able to realise his projects and his successor appeared to take no interest in them. But the ground had been carefully prepared. The Anglo-French Convention of August 5th, 1890, recognised the zone of French influence up to the Niger and Lake Tchad. A second Convention was signed with England on January 24th, 1899, confirming the rights of France over the whole of the country of the Touaregs, the Sahara properly so called, and over Tibesti, Ouadai, Baghirmi, Chari and Upper Oubanghi. The joining up of the Sudan, Algeria and French Congo was assured. At the end of this same year the Flamand Mission occupied In-Salah. Since that time we have witnessed an uninterrupted advance over a surface of more than 2 million square kilometres, 850,000 square miles.

This great stretch of country was endowed with a special administrative and financial organisation by a law of December 24th, 1902, but it was only from January 1st, 1906, that the new group began to work together with perfect regularity. It received the name of the "Southern Territories," and its frontiers were definitely fixed on the South by a convention of June 20th, 1909, becoming law on August 16th, 1911. It has taken 80 years then to fix the boundaries of Algeria.

There is now every appearance that the bases of the Saharian expansion are laid on their definite lines. Efforts have been made to reach Lake Tchad and the Niger in aeroplane and by trains of motor cars. Several of these enterprises are in hand at this moment, one or two of them starting from South Tunisia. Carriage roads have been already advanced as far as El Goléa. Regular touring circuits have been organised, taking travellers to the land of M'zab and the oases of Touggour and El Oued in the very centre of the great sand Erg, to Tozeur and to Gabes on the shores of the Syrtes.

But France has attached these vast territories to her North African empire with another view beyond that of displaying their picturesqueness to tourists. The men who have clung obstinately to the task of joining up with Equatorial Africa have set economical aims before them. Are the products of Equatorial Africa to journey towards Europe by land, crossing the desert and coming out on the southern coast ports of the Mediterranean? In this case, there is nothing to hinder France from constructing the necessary ways of communication. She will be mistress everywhere. On the subject of Saharian expansion I will quote a passage from Dr. Gasser, senator for Oran: "A far-seeing colonial spirit can no longer regard the trans-Saharian railway as an idle dream and the machinery for putting it into execution ought to be kept ready against the day when we have surmounted the present financial crisis."

Algeria then has her southern frontier. We no longer find those vague and unexplored regions, the famous "Mountains of the Moon," that figured on the maps of our childhood. From Algeria and the shores of the Mediterranean the authority of the Governor-General stretches inland to a distance of 2,000 kilometres (1,200 miles). On the east, the Southern Territories adjoin the Tripolitaine and Tunisia; on the west, they go right up to the ocean and the borders of Morocco, another 2,000 kilometres in breadth.

Over Tunisia and Morocco France has extended her protectorate and is now mistress of North Africa.

I have already drawn your attention to the geographical and ethnical uniformity of the northern part of this immense country. But it is far from enjoying uniformity of administration. This fact has been the subject of unending criticism. When the time came to organise the new possession, experiments were tried or, to put it more correctly, illogical methods were employed. The extension of the French occupation was not foreseen. No one took the trouble to study the native question. An administrative system copied exactly from

that of Paris was set working at Algiers. A certain person who had had a finger in the conquest and followed this up by giving the Government advice, invented with unconscious humour the astounding apothegm: "As soon as there are ten Frenchmen, they must nominate a deputy."

That was almost exactly what happened, and it was the beginning of all the mischief.

A few weeks ago, a French politician, then Prime Minister, said to me, "In all the countries of Europe, the parliamentary system is passing through a crisis." Here he was in agreement with Signor Mussolini who recently expressed the same opinion and in the same words. When you examine the too often unfortunate part that the French Parliament has played in the colonial expansion of France, you are indeed tempted to conclude that the parliamentary system lives in a permanent and hopeless state of crisis.

There were faults that asked to be committed and they were all committed. The work of organisation was imperative and there was no methodical plan to base it on. The rivalry between the army and the civil service soon developed into dissension with great detriment to the country. At Paris the parties in opposition to the Government demanded the abandonment of colonial enterprise in general and the evacuation of Algeria in particular. Adversaries and supporters of a colonial policy displayed equal bitterness and equal ignorance. Practical proof was given that France had no colonising experience. Theorists interfered, basing their theories on principles incapable of application. System followed system, incoherent and contradictory. Politics were brought into every question and the result was general confusion.

We will not here seek to put order into the confusion, for events are stronger than men and take it on themselves to confront antagonistic theories with accomplished facts.

There were then supporters of the civil administration and supporters of the military régime: pro-Arabs and anti-Arabs: all as uncomprising as each other. In spite of these contests, the administration blundered along somehow: the work of organisation continued: and such are the patience and tenacity of men, the country developed.

Finally Algeria was assimilated to France, but administrative regulations well suited to the French were applied to the radically different natives of the country, often in a manner opposed to common sense.

The natives became amenable to the French administration in a number of matters which were absolutely incomprehensible to them. For instance, a law of 1882 made the formalities of registration compulsory for the natives. Now a Mussulman has no family name and rarely knows his age. He sees no necessity for being in possession of these details, and the entering of his children at their birth on the State registers is a proceeding of which he does not understand the use: the tribe mark, tattooed on the forehead or the chin, is in his eyes a quite sufficient proof of identity. But they need papers when they have

to deal with the civil or military authorities and they always end by handing in a document which does not necessarily belong to them.

Professor Gautier relates the following anecdote:

In 1913 in the 'commune' of Ammi-Moussa, a caid went to the registrar's office to register his daughter's marriage, but he found that he had never registered her birth. It was extremely awkward. He was liable to a penalty of 50 francs, and the matter called for reflection. Meanwhile his wife gave birth to a little girl. It was a divinely sent chance of correcting a blunder of long standing without paying the fine. He registered the birth of girl-twins and the next day he returned to make the declaration of the marriage. "But you cannot marry a daughter one day old," said the clerk.

"A day old!" retorted the caïd, "she is seventeen. Do you want to see her?"

And after all it is not the caïd who provokes our smiles so much as the well-meant but ineffectual efforts of the French legislator.

On the same principle, before undertaking the construction of a house, a declaration has to be made at the local office of the Board of Health. A native builder was summoned to present himself at the office, because he had sent in an incomplete declaration. Day and hour were assigned for his appearance. He came three weeks later. The clerk asked him for the plans of the house in order to be sure that the sanitary regulations had been observed. "How can you ask me to bring you the plans of a house that is not yet built?" asked the astounded native.

These anecdotes prove that natives and Europeans do not see things in the same light and that the problem of assimilation is not yet near being solved.

It is thus that, very gradually, France has served her colonial apprenticeship in Algeria.

So when she assumed the protectorate of Tunisia and later that of Morocco, she had an experienced colonial staff at her disposal and profited by all the lessons she had learnt.

The convention between France and Tunisia for the settlement of the relations of the two countries is dated June 8th, 1883. It is signed by the Bey and by M. Paul Cambon who was the French Republic's first Resident-General at Tunis. It is particularly pleasant for me to pronounce before you a name that all respect and none will ever forget. Before being a great ambassador M. Paul Cambon was an admirable organiser and a clear-headed administrator. We have already seen how, in Algeria, the same high qualities had rendered M. Jules Cambon capable of preparing the occupation of the immense territories of the South. You will allow me to pay my tribute of respect to these two great servants of their country.

Tunis is indebted to-day to M. Paul Cambon for forty odd years of peace, order and prosperity. It was his work too, that inspired the great organiser of Morocco, and Marshal Lyautey would be the first, I feel sure, to admit that

the administrative measures adopted by him in Morocco were suggested by the example of Tunis.

What then has France done in Tunis?

She has maintained the monarchy. She has maintained as she found them the existing administrative services and has consolidated, reformed and extended them and assured their regular working. There could be no question, thank Heaven! of electing deputies, for the Dey kept his sovereign powers and the Parliamentary system had not yet been adopted in Mussulman countries. The emancipation of the natives had had such disheartening results in Algeria that no one could fall into the error of giving them any sort of right to vote. The Tunisian "fellah" besides would have been finely at a loss how to use his rights as a citizen. It was judged therefore, that until a certain stage of social evolution had been reached, it was preferable not to consult the Tunisian "masses" on the form of government they desired.

It does not seem that Tunis has reason to complain about what has been done for her.

When France came to Tunisia, the wheel was unknown. There were no roads, much less railways, no post, telegraph or telephone. She had no light-houses or beacons on her coasts, no ports, only shelters for small craft.

Agriculture was at a most primitive stage. Manufacture did not exist, or was represented by a handful of artisans working by routine and tradition. The agricultural hydraulic system was just sufficient for local needs, the irrigation of a few plains or palm plantations.

There was no such thing as security. The nomad tribes pillaged and raided each other.

The finances were in such a state that it had been found necessary to establish an international commission to assure the working of the Loans Department.

In short, the country was in a perilous state of stagnation; general ruin and individual poverty gained ground everyday.

Let us now follow out the work of re-construction, of which all the merit, let me repeat, belongs to M. Paul Cambon.

At no moment was there any idea of replacing the existing organisation by a copy of the organisation of France. At no moment was there any idea of assimilating the natives or giving them political emancipation. They remained subjects of the Dey and he remained their sovereign. They kept their institutions, their complicated legal system based on the Koranic law. No one interfered with their form of worship, their schools, their customs, and their religious establishments.

The political and administrative organisation of the protectorate was directed along parallel lines to that of the beylical organisation. It was a structure collateral to the one that existed. The Resident-General was at the head of it and its working was assured by a staff of French officials.

All foreigners came under French civil and criminal justice.

The army was reduced to one division. It has not been actively engaged for nearly 40 years and is rather a guarantee of peace than an occupying force.

The navy too has been reduced to a few insignificant units, and it must be admitted that neither soldiers nor sailors are a heavy charge on the budget of the Regency.

This brings us to one of the most important public services of the protectorate. We have just seen that the finances of the Bey had come to such a desperate pass that the Loans Department was placed under the control of an international commission. When France established her footing at Tunis, she accepted responsibility for the public debt and the commission was suppressed. And the Treasury has been so well organised and administered and the revenues from monopolies, taxes and all State resources so systematically collected that for nearly thirty years Tunisia has balanced her budget.

The financial management has been prudent. Too prudent indeed, it has been said. But it has contributed in a quite remarkable degree to the development of the country. Without a sound financial policy, nations, however great, may go to wreck.

Cast your eye over a map of Tunisia and you will see that she is now covered by a network of roads and railways. Without means of transport, all economic activity is at a standstill. Transport by ass or camel is very picturesque but necessarily of extremely limited capacity. It is hard to see, for example, how by these means the company of Gafsa would have been able to deliver at the ports of Sfax and Sousse the 1,700,000 tons of phosphates extracted from its mines 200 miles inland.

Roads and railways have now replaced the ancient tracks; mineral and goods trains, not to mention passenger trains, motor vans and motor lorries have supplanted the camel and the ass, and no one, I suppose, will deny that this is an improvement.

Roads and railways lead to ports, four great ports which did not exist before the days of the protectorate: Bizerte, Tunis, Sousse and Sfax. Seventeen smaller harbours are being improved in proportion to the demands made upon them.

I will now quote figures to give you an idea of the importance that has been attained up to to-day by the maritime trade of Tunisia. These figures are taken from the statistics for 1924. The number of ships entering and leaving harbour comes to a total of 20,438, registered at 7,000,000 tons and carrying 4,600,000 tons of goods and 138,000 passengers.

It is unnecessary to add that the creation of the ports has entailed the organisation of a whole system of light-houses, signal stations, light-ships and beacons, without which navigation would be impossible.

But what must not be left unsaid is that the creation of these ports, like the construction of the railways, has been conceded to private enterprise. In this

way there has been no charge on the budget of the protectorate, it has not been necessary to have recourse to loans. It is not for me here to take sides for or against universal State control, to praise or depreciate private initiative. Both systems have doubtless their good points: they meet temporary or local needs, the men who apply them are a great factor of their success. In any case the Tunisian ports have been constructed with the greatest rapidity: their mechanism is often more modern than that of more than one great European harbour, and they work with the most satisfactory results.

It is the same with the railways. Even during the War, there was no falling off in their activity. The traffic by rail augments and the revenues with it. The length of the railroad system is more than 1,200 miles and of the network of highways nearly 3,200 miles.

Means of communication have developed in the same proportion as the means of transport. The postal, telegraphic, telephonic and wireless services are directed by the State, and none the less efficiently directed for that.

For an excellent principle guides the action of administrative and public services in Tunisia, whatever they be. They are not looked upon as sources of income for the treasury. They are not constituted to supply the deficiencies of the budget, but to help forward the whole economic activity of the country, its agriculture, its commerce, its manufactures. They are not an end, but a means; and it is for this reason perhaps that their success is so marked. The principle is excellent. It ensures the effective working of the system, while leaving the system so elastic as to be able to adapt itself to the needs created by the development of the economic activity of the country.

Pray do not think that I claim for Tunisia perfect administration with which no fault can be found. No human institution is above criticism. If you read the minutes of the Grand Council of Tunisia, you will find in them a large number of complaints, suggestions, reproaches and even votes of censure moved by members of the Council. I should like to say a few words about the Grand Council.

Onward from 1577, the French merchants residing at Tunis had formed themselves into a group called the "Assembly of the General Body of the Nation." The Consul of France was the president of this assembly, the members of which were convoked "for the general and particular good" and were required to accompany the Consul "to audiences with the Beys whenever it seemed useful." The work of the Assembly was continued under the protectorate by the Consultative Commission and this Commission was replaced by the Grand Council, instituted on July 13th, 1922.

The Grand Council is divided into a French and a native section. Candidates are nominated and are elected for a period of six years. They discuss the budget and may offer suggestions on financial, economic and administrative points, but "the discussion of every motion of a political or constitutional order is forbidden." So runs a certain Article 15, as clever as it is concise.

But someone will ask, " Is it possible for men to live without politics ?" Let us see what answer our experience in Tunisia will allow us to make to this question.

If men were always animated by their zeal and only their zeal for the public good, they would of themselves banish politics from elected assemblies. This would not kill political doctrines any more than it would kill the political party system ; but then doctrines would be discussed by political parties in assemblies which would not be called upon to come to decisions on matters concerning the economic action of the community. The French Foreign Office, to which the protectorates are attached, has decided that politics are to have no more footing in Tunisia than in Morocco. This attitude is in harmony with the spirit and letter of the treaties, for France has signed them conjointly with the Sovereign Bey or Sultan, and has engaged herself to them " to lend them constant aid against all dangers menacing their persons and dynasties, and compromising the tranquillity of their States." By these words, politics are well and duly put out of pain, and Article 15, quoted above, sets it beyond all question that the knell of politics has definitely sounded.

It is a wise precaution, for the monster is hydra-headed. We all of us know what an electoral campaign means, in France or in England. If you are to believe the candidates' speeches, the words of the election agents and the posters that cover the hoardings, the electors have to choose between blackguards, rogues, sots and idiots or combinations of all these things. These insults are forgotten the day after the poll, and you are not long in finding out that our representatives are upright and keenly intelligent men, that the proportion of idiotic to reasonable members is immensely reduced and that no dishonest or unscrupulous person ever sits in Parliament.

However, it certainly is a wise precaution not to display our electoral methods before the natives. I was present at the Oran municipal elections. The insults dealt out on the posters or in the press were Homeric and such blows were exchanged after meetings that stubborn electors were left for dead in the streets. I felt a melancholy regret that the spread of education enables such a large number of natives to read the posters and the papers, and that the sight of the wounded men on the pavements makes them think of the days when they worked on those lines, but more efficiently. Like France, Algeria is delivered up into the hands of politics.

Some few weeks later I was at Fez in Morocco, where, as in Tunisia, politics have been done to death. But still the members of the elected bodies, the chambers of commerce, have to solicit the votes of the electors. They were doing so at Fez. There were posters, but at least they had the merit of being very small and contained only a few sentences. Like good political candidates, the adversaries refrained from enumerating their own virtues and took great care to abuse their opponents. But I must admit that they did so with a certain correctness. " Mr. X disguises the truth," said one. " Mr. Y misre-

presents the facts,' rejoined his adversary. They did not go so far as to call each other liar and forger, but they left the elector to draw conclusions of these tendencies. And meanwhile Abd el Krim's "harkas" were coming down from the north.

At Casablanca, where the French colony is in the majority, French customs were more closely followed and the struggle was keen. The candidates did not hesitate to call each other quacks, hypocrites, toadies, traitors and bigots. All this for a seat in the Chamber of Commerce!

Politics really are not made for exportation!

That is what Marshal Lyautey thought when he began to organise Morocco. M. Steeg understood it too when he was nominated Governor-General of Algeria.

There are periods when, for reasons which we will not enter into here, politics have the upper hand in Algeria. Immediately everything goes wrong and, in the confusion, there is always the danger of the native turning 'rogue.' Governor-General Steeg arrived on the scene in time to stave off this danger. He cleverly directed all minds towards a purely economic policy that he called the 'water policy.' At the beginning of this lecture I promised to return to the subject of rainfall and it is now the moment to give a brief summary of M. Steeg's policy. The rain question is a vital one. Without water, North Africa is the victim of drought, which entails shortage of cereals, failure of crops, cattle disease, the ruin of agriculture. But yet the average rainfall in Northern Algeria is exactly the same as that of France as a whole, namely, 766 millimetres, roughly 30 inches. But as the rain descends on deserts, it runs off to the sea or to sandy wastes which absorb it before, on its passage, it can be utilised for watering and fertilising the fields. What is important then is to store it up and distribute it as necessary; and this is the problem that M. Steeg has solved.

Before his day the application of hydraulics to agriculture had been curiously neglected. Is it not surprising that, from 1880 to 1903, only the ridiculous sum of 600,000 francs was allotted to this purpose in the Algerian budget? The sum was consequently doubled, but it was still absurdly inadequate. As soon as he arrived, M. Steeg had a programme drawn up and was given 21 millions a year for five years to carry out this plan. Thus it has been possible to set gigantic schemes afoot. To give you some idea of these, let me tell you that the dam now being constructed at Oued Fodda will be 330 feet high, will hold up 300,000,000 cubic yards of water and irrigate 48,000 acres of land suitable for the growing of cotton.

This water power will be utilised for working turbines which will supply the district with electric light and force. Several more dams are to be constructed promising vast extensions of irrigation, regularity of crops and also that electric power which the scarcity of coal now renders much too costly. Not only will agriculture be widely developed, but it will mean the beginning of a manufacturing activity that has hitherto been lacking in the country. The treasury

will have a consequent source of more regular and considerably increased revenues. It will also become possible to replant the slopes with trees and to reconstitute the forests destroyed by invading Arabs and reckless natives.

We may, therefore, anticipate a rapid development of Algeria which, in spite of its defective organisation, promises to outstrip greatly its neighbours, Morocco and Tunis, though better governed.

I may remark that a hydraulic programme is under consideration for Tunisia, whose deserts of to-day will become again as densely wooded, as thickly populated and as prosperous as they were when the country was the proconsular province of Roman Africa, and, if we may believe the Latin authors, one travelled from Hadrumetum to Tebessa in the shade of olive-trees.

Of the olive trees of the Roman epoch there remained only a few clumps along the coast when the French came. Inland, the memory of the trees was kept alive by the name Djebel Zitoun, Mount of Olives, that the natives still give to woodless ridges.

Taking up Rome's work, France is planting olive trees in regions where absolutely everything had ceased to grow, round Soussa, round Sfax, and in the interior. These plantations date from a score of years back and are beginning to give full crops. Tunisia can to-day count her 15 million olive trees and thousands of acres are being annually added to the plantations.

In Algeria, M. Steeg's "water policy" includes the boring of numerous artesian wells in desert regions where the Oueds lose their water in the sand. The object here is not to adapt land to agriculture or cotton-growing, but to create palm-groves.

What charming associations cling to the word palm-grove! You see it in its three storeys. The top storey is that of the tree-crests, with their great fans and clusters of dates. Next come the fruit trees, apricots, pomegranates, almonds and figs. Then, on the ground floor, so to speak, you have the little irrigated patches of barley, carrots, and other vegetables. But there are no orange or lemon trees in the oases, because the water there contains certain salts that these trees cannot support. We must not forget the basement from which the water comes up by artesian wells. M'zab gives you another picture. The oasis has 3,000 wells with creaking pulleys and from morning to night slow camels haul up the full skins that are discharged into cisterns.

The desert has water, in subterranean sheets, sometimes situated at great depths. M. Steeg's programme includes the search for these sheets, and one has already been found under the long oasis of Oued Ghir, north of Touggourt. There, at Mraier, a sinking operation, undertaken in the hope of saving an oasis the drying-up of whose fountains condemned it to perish, sent water spouting up one night at the rate of 40,000 litres (nearly 10,000 gallons) a minute. This was far too much and the outflow was reduced. Other soundings are being made around the new wells, new palm-groves have been planted, and in no distant future the tourist taking the "white train" from Biskra

to Touggourt will travel for 150 miles under the shade of one unbroken palm-grove. And there is a whole region growing rich, for palm culture and the date trade are extremely lucrative.

In the matter of water Morocco is doubtless more favoured. The Atlas ranges are higher there and keep their snows longer. On certain peaks indeed the snow is eternal. From mid-Atlas descend four great "oueds" with an output of water that diminishes in summer but never dries up entirely. So their utilisation for hydraulic purposes is decided on, and gigantic power-stations will soon be distributing the electric current over all Morocco. The railway lines, whether completed or in course of construction, are bordered by iron pylons ready to carry the transmitting cable.

But it is high time to conclude, and I have not yet spoken to you of what France has done in other domains equally important. I have not touched on public education, in European and native schools, the technical classes attended by native pupils in ever greater numbers, on the poor-law administration, the hospitals, the travelling medical and veterinary services which visit the tribes with the result of a decreasing death-rate and a rising birth-rate, on the repression of contagious maladies, under which head it is foreseen that the curse of venereal diseases will have disappeared in ten years. Everywhere proof abounds of impartial care for the happiness and prosperity of all, Europeans or natives. And I must mention a subject which is dry indeed, but cannot be omitted, everything, I mean, that has been done to foster agricultural, commercial and social clubs, co-operative stores, popular banks, insurance companies, lending banks, and native savings banks.

Each of these subjects calls for a separate lecture. But there are limits to everything and I hope I have said enough to show you that France has met with considerable success in her work of colonising North Africa.

I should like to think also that I have inspired you with the wish to visit the country.

For the lovers of picturesque journeys North Africa is an ideal country. Even if his curiosity is superficial and does not extend to the questions that lie behind the animate and inanimate objects on his path, the traveller cannot fail to be struck by the infinite variety of the pictures that pass before his eyes. Even if he has no desire or no time to analyse them, his impressions will make up a pleasant whole and he will keep a charmed memory of his wanderings. Even if the "modern comfort" promised him has at times not quite come up to his expectations, he will have accepted such little accidents with equanimity, more than repaid for them by the sights and the landscapes he has seen.

In every country two factors are indispensable for travellers and travelling agreeably: transport and hotels. Several companies ply on the maritime routes leading to North Africa and run excellent boats. The land service is assured by road and rail. In certain districts, the railway alone is available. For instance, in Tunisia, if you want to go from Sfax to Gafsa and return to

Sousse round by the Roman ruins at Sbeitla. To go from Oran by Aïn-Sefra to the beautiful oasis of Figuig, you must take the Colomb-Béchar line and pass the night in the comfortable sleeping-berths, for, since the construction of the railway, the military authority has let the old track fall into disuse and the Civil Engineering Service has not taken charge of it. On the contrary, between Algiers and Bou-Saada, Laghouat and the curious land of M'zab, there is no communication but by road and track. In Morocco no one ever dreams of taking the train: up to quite recent days the railway system was a narrow-gauge one and was used almost exclusively for the needs of the army and the transport of goods.

The roads of North Africa are much more highly developed than the railroads. The roads of all sorts are in general well kept up and are used by motor vehicles of every description. There is hardly a locality that does not boast its motor transport enterprise with a stock that varies from a few primitive cars to rapid limousines and charabancs holding from twenty to thirty travellers.

The picture would be incomplete if we forgot to mention the luxurious cars of the General Transatlantic Company, which during the touring season rush along the highroads from Tunis to Casablanca and from Algiers to Constantine and Biskra.

Thanks to the initiative of the General Transatlantic Company the traveller is sure of finding comfortable quarters when he leaves the great coast towns and makes for the oases of the desert. At Biskra, Constantine and Tunis, the Company has constructed palatial hotels, elsewhere it has adapted old princely residences, as at Marrakech and Fez. At Laghouat in the heart of the desert, the delighted traveller finds himself in an Arab villa under the palm-trees and can sleep in a tent pitched in the garden all among orange trees. The accommodation is limited, but if one sets about it in time one can at any rate be assured of excellent food and lodging, good gifts that are highly appreciated after long stages in motor cars.

The Paris, Lyons and Mediterranean Company also has organised an excellent system of motor car transport that supplements her railways very agreeably. Great efforts indeed are made to render journeys pleasant without making them too costly.

And you can travel in complete security, without arms or escort. I have never carried a weapon, never even a revolver, in Tunisia and Algeria, and it was only when I was following the operations against the Rifians that I was provided with a rifle. I never had occasion to use it.

And this brings us to the summary with which I will close:

France has restored North Africa to health, material and moral.

She has suppressed slavery and anarchy.

She has created means of transport and brought back security.

She has roused men to action, fertilised the soil, given economic prosperity.

It is eighteen centuries since North Africa was lapped in the *Pax Romana*.

France may be proud of spreading to-day in North Africa the *Pax Gallica*.

DISCUSSION.

His Excellency the Marques Merry del Val, the Spanish Ambassador, thought he interpreted the feelings of those present when he said that they had listened with the greatest interest and appreciation to the very lucid and complete lecture given by M. Davray. He imagined that for the great majority M. Davray had said nothing new, because he spoke before an audience well acquainted with the subject of African civilisation and exploration, and with the general development of that Continent, but he felt sure that everyone had listened to the author, as he himself had, with the greatest pleasure. He had come to the lecture that afternoon with a sense of deep gratification, for three reasons. In the first place he had felt honoured by the invitation received from the Royal Society of Arts, which had such a great reputation and such a brilliant and well-established tradition, to attend a meeting under the Chairmanship of Sir Frederick Lugard, one of the builders of the British Empire whose name would always be associated with the history of Africa. In the second place it was extremely agreeable to him to pay a most merited and justified tribute to the work of France in North Africa. He thought that nowhere more than in Britain, a nation which had had such a great experience of Colonial work, would the extraordinary achievements of France in North Africa be better recognised. Speaking as a foreigner in this country, he might add that nowhere were those efforts better appreciated than in Spain. Certainly one of the greatest tributes to the work of France in Morocco had been paid by one of the most successful administrators in the Spanish zone of Morocco, General Berenguer, whose work would be always of the greatest value in connection with North Africa. The Spanish Press had not stinted its praise of the work of France in North Africa, and General Primo de Rivera, the present head of the Spanish Government on his part, had been a great admirer of Marshal Lyautey and had never hidden his admiration for that great administrator. In the third place he was glad to be present that evening to say a word in regard to the work of his own country in North Africa. From the military point of view he was afraid that the action of Spain had been greatly distorted. From the reports received in this country one was led to believe that the work of Spain for civilisation and colonisation had been utterly forgotten, perhaps purposely. If France had worked, and worked as such a great nation could, in North Africa, Spain had also done her bit. She had built many hundreds of miles of roads with their bridges and culverts and had established the telephone and telegraph. The first two railways made in Morocco were built by Spain, one from Melilla to the interior, the other from Ceuta to Tetuan. Native schools had also been established with the greatest regard for native beliefs, and the first action taken by any Spanish column establishing a permanent base was to protect natural springs of water by masonry, for the use, not only of the Army, but of the natives and to open a dispensary specially reserved for the use of the native Moors. Spain had also something to her credit in the sphere of agriculture, having established model farms, both in the east and west of her Protectorate, equipped with agricultural implements of the latest type, and there was an arrangement for loaning these to the natives. The Moor availed himself very generally of these appliances, carrying the implements to his tribe and bringing them back with the greatest honesty after a time.

He wished to ask the audience to express again their great appreciation of the very interesting view of the whole of that great and glorious work of France in North Africa which had been described by the author of the lecture.

THE HON. HUGH A. WYNDHAM said he listened to the paper with very great interest, more particularly because he had spent most of his life in South Africa. It seemed to him that France in North Africa was engaged in very much the same work which was occupying the British Empire in South and East Africa. France was engaged in settling a European population in North Africa in the midst of a native population already in existence, and that was what the British were trying to do in East Africa and South Africa. Two very difficult questions were raised in M. Davray's paper. In the first place there was the political question, and he was interested in what the author said on that point. The matter of the Grand Council of Tunisia was one of great interest, and he should like a great deal more information in regard to that Grand Council. It was a very interesting experiment which South Africa contemplated following, and it had, to a certain extent, been followed in East Africa—that was the complete division between the European population and the native population where politics were concerned. He had been very much interested in what the author said with regard to the exclusion of politics from the purview of the Grand Council. That was the case, he believed, under Section 15 of the Constitution, but he was under the impression that, though the European had franchise rights for that Council, it was not the same with the natives, and that full control of the Council remained in the hands of the Europeans. That was, he thought, as it should be, because naturally the Europeans were responsible for introducing civilisation into the country, and they could not take the risk of having that responsibility interfered with; but it was an interesting point in South Africa as to how to give the native population a voice in the government of the country and at the same time to retain complete control in the hands of Europeans, a control which was essential. If the author could work that out a little and mention it in his reply he should be very much obliged to him. Another point was the effect of settling Europeans, French or English, in the midst of natives. The author had quoted Prof. Gautier's book, and if he remembered rightly, Prof. Gautier quoted certain cases in which native ideas had had a rather bad effect on the French settler, and quoted one case of a French settler who tied a charm round his cow's neck with a view to preventing disease. Similar cases might be found in Africa. The fact that some white people who lived among natives deteriorated was a serious hindrance to the adoption by the country of European civilisation. He should like to hear the author's views on that point.

HIS EXCELLENCY BARON MONCHEUR, the Belgian Ambassador, having been asked to say a few words, briefly reminded the audience that Belgium too had become an important colonial Power in Africa. Following the explorations of Stanley, Leopold II foresaw the tremendous future of the mysterious Continent The genius of this great Sovereign transformed Darkest Africa into a prosperous colony where slavery and cannibalism were to-day but a memory of the past and where flourishing industries were spreading everywhere. Belgium, like her Allies who shared Africa with her, would always strive for the moral and material welfare of the races under her care. There were immense possibilities in the African continent if the reign of Justice, Work, and Peace could but be firmly established there.

THE CHAIRMAN said it devolved upon him as Chairman to express on behalf of those present their thanks to M. Davray, for the exceedingly interesting lecture he had given, and also to thank their Excellencies and Mr. Wyndham for their

remarks, which had rendered the lecture still more interesting. He did not think that any English audience could have listened to the paper without thinking how close a parallel this country could offer in its colonial expansion to the story which the author had unfolded. We too had heard the voice of the little Englander declaring that in this or that colony cemeteries were the only things that prospered and that the only remedy was evacuation. Probably some present would recall that in 1867 or 1868 the evacuation of the whole of West Africa was recommended, and in his own experience a similar decision was arrived at with regard to Uganda, a decision which was fortunately reversed. Great Britain, like France, had, however, learned that the great leading civilised powers had responsibilities which they could not evade, and he hoped that the great political parties would in the not distant future agree that the continuity of colonial policy should be outside and above all party questions. Already, to a large extent, it had been possible to exclude from party politics questions of foreign policy. The lecturer had described very graphically how France began her work in Algeria by shipping off the Sultan to the Far East, and had told us how France then introduced a system of administration based on the model of the Mother Country, how theorists elaborated policies which were absolutely unfitted to the race and religion of the people with which she had to deal, and how M. Paul Cambon—a name which he had rightly said was regarded with great honour and respect in Great Britain—introduced the principle of ruling through the native chiefs and in accordance with native ideas. Great Britain also had evolved a similar policy in the last 25 years, and as in France its results had been to produce loyalty and prosperity. He thought few people had realised that although France had been in Algeria now for 95 years, it was only in the last 20 years that the new era of material development, of electric power and irrigation, and rapid progress, had been inaugurated. It was indeed a very remarkable story which M. Davray had told that evening. This advance had been made possible by the work of M. Paul Cambon, and it was to be hoped that, as soon as the temporary difficulties with which France was involved with the Riffs were settled, similar progress would be seen in Morocco, where that great Administrator Marshal Lyautey had already laid the foundations. His own experience as a member of the Permanent Mandates Commission of the League of Nations had brought very vividly before him the identity of the problems with which the different nations in Africa had to deal and the diversity of the solutions that were brought forward. The era of competition which at one time was very acute between this country and France had passed, and there had now been reached the era of co-operation. The lecturer that evening had done so much to explain the two nations to each other that he hoped he would give his powerful assistance to add to and improve that mutual understanding. In the name of the Royal Society of Arts, and of the audience that evening, he offered to M. Davray their most hearty thanks for the very interesting lecture he had given.

THE AUTHOR said, with reference to Mr. Wyndham's remarks, that French internal policy in North Africa for the last three years had been giving good results. In Algeria an elected body, which controlled the financial administration, dealt with economic problems and the question of co-operation between natives and Europeans, and it worked extremely well. To go into the matter, however, would require a whole lecture.

A vote of thanks to the Chairman concluded the meeting.

NOTES ON BOOKS.

Six French Artists of the Nineteenth Century. By Frank Gibson. London : Robert Scott. 15*s*. net.

Each of the six sections into which this book is divided contains a short critical appreciation, with some biographical details, of the work of one of the following French artists of the nineteenth century, Delacroix, Corot, Millet, Cazin, Rousseau, and Puvis-de-Chavannes. Mr. Gibson's criticisms are sympathetic, and the dozen pages more or less which are devoted to each artist are sufficient to serve as an introduction to one of the most interesting chapters in the history of painting. The twelve full-page illustrations by photographic reproduction are well done, and convey a good idea of the special characteristics of the art of each painter. We have in London very few examples of the painting of the French masters of the nineteenth century outside the small but admirable Lane collection at the Tate Gallery, but we may hope that the example given by Sir Joseph Duveen in building an addition to the Tate Gallery for the reception of examples of modern foreign art, and by Mr. Samuel Courtauld in providing it with an endowment for the purchase of modern French pictures, will be followed by other benefactors, so as to enable English lovers of painting to acquire a more extensive knowledge of modern foreign and especially French painting than is possible at present.

Colour Mixing and Paint Work : a Practical Manual for Painters, Sign-writers, Artists, etc. By D. F. Cary. London : Crosby, Lockwood and Son. 2*s*. 6*d*. net.

The Science of Colours and the Art of the Painter. By Maurice Boigey. Translated by J. B. Hewitt. London : John Bale, Sons and Danielson, Ltd. 7*s*. 6*d*. net.

The aim of both these books is similar : that of instructing those who use paints, but the points of view are different and they overlap very little so that a person interested in either will require the other.

Mr. Cary aims at conciseness. Thus when introducing his subject he touches on the oil, driers, body colours and turpentine : giving his reasons for mixing by addition to the oil in this order or sequence. He also combines reasons with precept in suggesting that, when mixing colours to match, a piece of glass should be used as a base on which to compare.

Pigments are considered, each in a short paragraph with brief indications of chemical nature, impurities, adulterations and special facts of importance ; thus under zinc white we are reminded of its use as a final coat over white lead. Under cadmium yellow there is a caution against its use in admixture with white lead, and under "manganese dioxide black," there is a hint as to its value when quick drying and intense blackness are required.

M. Boigey does not discourse of the chemical nature of the pigments, but he gives tables showing how tinted lights affect the appearance of the painted surface, his key-note being pictorialism. His very able digest of practice and theory as bearing on the Young-Helmholtz colour-concept is lucid and admirable, although he avoids as far as practicable the inevitably narrow dialect of the physical laboratory. Every artist painter should obtain both books.

CORRESPONDENCE.

"THE FUTURE OF THE MOTOR CAR."

Mr. Arnold Lupton's questions in his letter in your issue of 22nd January are, perhaps, not so simple as they seem. They appear to be a challenge to open an argument on Free Trade.

1. An "opinion" from Sir Alan H. Burgoyne's paper is quoted, and statistics relative to numbers of cars in use in various countries (all harder hit by the Great

War than the United Kingdom) are quoted, apparently as a refutation of the "opinion." What connection have the statistics quoted to the "opinion," other than the implication of Mr. Lupton's own view that the United Kingdom is fundamentally better off because we have more cars, relatively, than the other countries named; ignoring the fact that the United Kingdom happens to be at the moment better able to afford cars.

The real question which requires an answer is, which country gains most—the country which protects its industries and employs its people, or that which does not?

What the farmer or anyone wants in Italian or any foreign-made cars, has so little to do with the point at issue, that one is not astonished when the further question put by Mr. Arnold Lupton has in its premise a *suggestio falsi*, which is intended apparently to confuse the issue in the question itself.

2. "If he (*i.e.*, the aforesaid farmer) had an import duty that would raise the 9d. loaf 33⅓ per cent. to 1s., would that meet with the approval of those who approve the import duty on cars?" Really, is this a fair question? Who does not know that an import duty on wheat sufficient to raise the price of the loaf from 9d. to 1s. would be nearer 100 per cent. than 33 per cent. Perhaps Mr. Lupton would not agree: but most people think that we should grow more wheat, have a larger arable area generally, and employ more people in agriculture: and very many think that a variable corn import duty made actuarily applicable to fluctuating prices in the world's markets, which gave our farmers a certain price of 60s. for wheat, year in, year out, would so stabilise farming in England that all the national services to Agriculture before mentioned could and would be realised.

C. M. P. WRIGHT.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 8..Brewing, Institute of, at 39, Coventry Street, W. 6 p.m. Mr. S. Dickinson, Demonstration of Isolation of Single Cells for the Preparation of Pure Cultures of Yeast and Bacteria. 7.45 p.m. Mr. S. H. Hastie, "Character in Pot Still Whisky."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Mr. R. J. Mitchell, "Modern Applications of Ball and Roller Bearings."
At Armstrong College, Newcastle-on-Tyne. 7 p.m. Prof. Dr. S. P. Smith, "An All-Electric House."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Colonel Sir Francis Younghusband, "The Problems of the Shaksgam Valley."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Mr. James Gilchrist, "Wire Weaving."

Société Internationale de Philologie, Sciences et Beaux-Arts, 8, Taviton Street, W.C. 3.30 p.m. Mr. A. J. Hughes, "Unemployment Insurance."

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. E. M. Konstam, "The Rating and Valuation Act, 1925."

Structural Engineers, Institution of, at 2/8, Victoria Street, S.W. 6 p.m. Mr. H. Kempson Dyson.

Victoria Institute, at Central Hall, Westminster, S.W. 4.30 p.m. Prof. F. F. Roget, "A Philosophic Exponent of Latin Culture, Alexandre Vinet: Protestant Divine and Literary Critic (1797-1847)."

Mechanical Engineers, Institution of, Storeys Gate, St. James's Park, S.W. 7 p.m. Mr. E. C. Peters, "Submerged Combustion and Submerged Flame Burners."

University of London, at King's College, Strand, W.C. 5.30 p.m. Baron A. F. Meyendorff, "Tendencies and Types of Agrarian Legislation in Eastern Europe." (Lecture II.)
At the Institute of Historical Research, Malet Street W.C. 5.30 p.m. Dr. Dragutin Subotic, "The Battle of Kossovo (1389) in Serbian Traditional Poetry." (Lecture II.)
At University College, Gower Street, W.C. 4.30 p.m. Mr. Henry Higgs, "Some Social Problems in the Light of Economics and Statistics." (Lecture IV.).
5.30 p.m. Mr. M. H. Krishna, "Indian Archæology and Anthropology." (Lecture IV.)
5.15 p.m. Dr. R. W. Lunt, "The Chemistry of Ionization by Collision." (Lecture II.)
At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture II.)
At King's College, Strand, W.C. 5.30 p.m. Prof. Gaetano Salvemini, "The Political Evolution of Italy in the Nineteenth Century." (Lecture II.)
5.30 p.m. Dr. F. A. Aveling, "The Human Will." (Lecture IV.)

University of London, at University College, Gower Street, W.C. 5.30 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture IV.)
4 p.m. Prof. A. V. Hill, F.R.S., "The Physiology of Muscle." (Lecture II.)

TUESDAY, FEBRUARY 9..Aeronautical Engineers, Institution of, at 39, Victoria Street, S.W. 6.30 p.m. Informal Meeting.

Colonial Institute, at Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m.

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. P. W. Bertlin, "Construction of the new Entrance to Tranmere Dock."

Electrical Engineers, Institution of, at the College, Loughborough. 6.45 p.m. Mr. R. C. Clinker, "The Constants of an Electric Circuit."
At the Hotel Metropole, Leeds. 7 p.m.
At the Royal Technical College, Glasgow. 7.30 p.m. Prof. Dr. S. P. Smith, "An All-Electric House."

London College of Physiology, 8, Taviton Street, W.C. Dr. J. Barker Smith, "Taking Cold—Sequelae and Therapy."

Petroleum Technologists Institution of, at Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Messrs F. Challenger, J. Haslam, R. J. Bramhall, and J. Walkden, "The Sulphur Compounds of Kimmeridge Shale Oil."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Meeting of Scientific and Technical Group.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. Eric K. Rideal, "Surface Action." (Lecture II.)

Zoological Society, Regents Park, N.W. 5.30 p.m. Scientific Business.

University of London, at Bedford College for Women, Regents Park, N.W. 5.15 p.m. "Great English Women Novelists." (Lecture I.)

University of London, at the London School of Economics, Aldwych, W.C. 5 p.m. Mr. H. J. Laski, "Adam Smith and Political Thought."
At University College, Gower Street, W.C. 5.30 p.m. Prof. G. S. Gordon, "The Youth of Milton." (Lecture I.)
At the Institute of Historical Research, Malet Street, W.C. 4 p.m. Prof. Janko Lavrin, "Slovene Literature." (Lecture II.)
At King's College, Strand, W.C. 5.30 p.m. Miss H. D. Oakeley, "Philosophy and History." (Lecture II.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture IV.)

WEDNESDAY, FEBRUARY 10..Civil Engineers, Institution of. Great George Street, S.W. 6 p.m. Mr. W. A. Willox, "British Railway Permanent Way Maintenance."

Heating and Ventilating Engineers, Institution of, Holborn Restaurant, W.C. 2.30 p.m. Annual General Meeting. 7 p.m. Mr. H. G. Cathcart, "Engineering Services in Hospitals and Asylums."

Structural Engineers, Institution of, at Manchester. Prof. A. E. Richardson, "The Relation of Architectural Design to Structure."

Royal United Service Institution, Whitehall, S.W. 3 p.m. Lieut.-Col. Fagalde, "French North Africa with special reference to Morocco."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. Philip Guedalla, "Lord Palmerston."
At University College, Gower Street, W.C. 5.30 p.m. Dr. J. Haantjes, "The Flemish Author, Felix Timmermans."
5.30 p.m. Mr. J. H. Helweg, "Literary Criticism in Denmark in the XIXth Century." (Lecture I.)
3 p.m. Prof. E. G. Gardner, "The Purgatorio of Dante." (Lecture IV.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Earliest Civilisation of the Slavs." (Lecture IV.)

THURSDAY, FEBRUARY 11..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, at University College, Gower Street, W.C. 8 p.m. Prof. J. Barcroft, "Hæmoglobin."

Electrical Engineers, Institution of, at University College, Dundee. 7.30 p.m. Mr. T. Carter, "The Engineer: His Due and his Duty in Life."

Historical Society, 22, Russell Square, W.C. 5 p.m. Prof. Dr. T. F. Tout, Presidential Address.

Metals, Institute of, at 85/88, The Minories, E. 7.30 p.m. Mr. H. J. Gough and Dr. D. Hanson, "The Fatigue of Metals: A general Survey and an Account of some recent Work." (Part II.)

Optical Society, at Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m. Annual General Meeting.

Oil and Colour Chemists' Association, at 8, St. Martin's Place, W.C. Dr. L. C. Martin, "Colour Measurement."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. J. L. Myres, "Who were the Greeks?" (Lecture II.)

Royal Society, Burlington House, W. 4.30 p.m.

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Mr. Bernard Rackham, "Stained Glass."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Mr. J. F. Keel, "Elizabethan Vocal Music."
At the London School of Economics, Aldwych, W.C. 5.30 p.m. Dr. W. C. Dickinson, "The Norman Influence."
At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Customary Law in Europe." (Lecture III.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk-Mirsky, "Early Russian Literature." (Lecture V.)
4 p.m. Mr. I. L. Evans, "Economic Development of South Eastern Europe." (Lecture II.)

University of London, at King's College, Strand, W.C. 5 p.m. Dr. J. A. Hewitt, "Metabolism of Carbohydrate and Fat." (Lecture IV.)
At University College, Gower Street, W.C. 5.30 p.m. Mr. F. Keel, "Elizabethan Vocal Music."

FRIDAY, FEBRUARY 12..Engineering Inspection, Institution of, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. S. E. Dawson, "The Application of Special Cast Irons in the Engineering Industry."

Electrical Engineers, Institution of, at the City Council Chamber, Birmingham. Mr. C. O. Silvers, "Road Transport and its possible Developments." (Joint Meeting with the Institutions of Civil and Mechanical Engineers.)

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Honorary Members' Lecture.

London Society, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Mr. John Bailey, "The Abuse of Public Advertisement."

Metals, Institute of, at the University, St. George's Square, Sheffield. 7.30 p.m. Dr. O. F. Hudson, "Drop Forgings."
At University College, Singleton Park, Swansea. 7.30 p.m. Captain L. Taverner, "Observations on Copper Metallurgy."

Mechanical Engineers, Institution of, at the Philosophical Hall, Park Row, Leeds. 7.30 p.m. Mr. A. P. Hague, "The Choice of Steels for General Engineering Work."
At Storey's Gate, St. James's Park, S.W. 7 p.m. Mr. G. C. Hodson, "Refrigerating Machinery.",

Société Internationale de Philologie, Sciences et Beaux-Arts, 8 Taviton Street, W.C. 8.15 p.m. Mr. Patrick Braybrooke, "Kipling."

Physical Society, at Imperial College of Science, South Kensington, S.W. 5 p.m.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. R. Robinson, F.R.S., "The Chemistry of Blue and Red Colouring Matters of Flowers."

University of London, at University College, Gower Street, W.C. 5 p.m. Dr. Geoffrey Martin, "The Theory of Fine Grinding."
5.30 p.m. Miss Eleanor Hull, "Ireland from the Earliest Times." (Lecture IV.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Making of Modern Roumania." (Lecture II.)
At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. Graham Wallas, "Social Leadership." (Lecture I.)

SATURDAY, FEBRUARY 13..L.C.C. Horniman Museum Forest Hill, S.E. 3.30 p.m. Mr. H. N. Milligan, "Sea-Shells and their Makers."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Walford Davies, "The Triad and the Perfect Fourth—their Uses from Hucbald to the Present Day."

Transport, Institute of, at the Town Hall, Newcastle-on-Tyne. 3 p.m. Mr. D. S. Burn, "Notes on Railway Organisation."

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3821 VOL. LXXIV.

FRIDAY, FEBRUARY 12th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 15TH, at 8 p.m. (Cantor Lecture.) G. W. C. KAYE, O.B.E., M.A., D.Sc., Superintendent, Physics Department, National Physical Laboratory, "The Production and Measurement of High Vacua." (Lecture I.)

WEDNESDAY, FEBRUARY 17TH, at 8 p.m. (Ordinary Meeting.) JAMES EDWARD TAYLOR, M.I.E.E., Superintending Engineer, Post Office Telegraphs, etc., South Midland District, "The Propagation of Electric Waves." ADMIRAL OF THE FLEET, SIR HENRY JACKSON, G.C.B., K.C.V.O., D.Sc., LL.D., F.R.S., will preside.

FRIDAY, FEBRUARY 19TH, at 4.30 p.m. (Indian Section.) SIR MICHAEL F. O'DWYER, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab, "Races and Religions in the Punjab." (Sir George Birdwood Memorial Lecture.) THE RIGHT HON. THE EARL OF RONALDSHAY, G.C.S.I., G.C.I.E., late Governor of Bengal, will preside.

CANTOR LECTURE.

MONDAY, FEBRUARY 1ST, 1926, MR. H. P. SHAPLAND, A.R.I.B.A., delivered the third of his course of three lectures on "The Decoration of Furniture."

On the motion of MR. PERCY WELLS, of the Shoreditch Technical Institute, a vote of thanks was accorded to Mr. Shapland for his very interesting course.

The lectures will be published in the *Journal* during the Summer recess.

EIGHTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 3RD, 1926. THE RIGHT HON. LORD CLINTON, Chairman, Lawes Agricultural Trust, in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

Benton, Clifford, London.
Corbett, Charles Foster, Edmonton, Alberta, Canada.
Mathur, Achleshwar Nath, Alwar, India.
Savage, John Arthur, London.
Steven, Robert Ernest, São Paulo, Brazil.
Whitehouse, J. Howard, Bembridge, Isle of Wight.
Whittaker, Captain Harry (late R.E.), B.Sc., Lahore, India.

The following candidates were duly elected Fellows of the Society:—

Arbogast, Victor Rice, Paris, France.
Barton-Wright, Edward William, London.
Bickle, Horace William, Plymouth.
Birkett, E., Ashford, Kent.
Blackwell, William, Erdington, Birmingham.
Bonsor, H. S., B.Sc., Kapurthala, India.
Cockaday, Laurence Marsham, New York City, U.S.A.
Coombs, Rev. W. M., Hulme, Manchester.
de La Perrelle, Colonel John Nathael, London.
de Silva, Daniel Oswald Oliver, Hongkong, China.
Gernsack, Hugo, New York City, U.S.A.
Gray, Wyndham Charles, London.
Griffin, Rev. Charles Alfred, Ph.D., Litt.D., Warrington.
Hibbs, Rev. H. H., D.D., Smithland, Kentucky, U.S.A.
Holmes, Captain Alfred Philip Hanby, M.C., B.Sc., Penang, Straits Settlements.
Hukins, Alexander Edwards, London.
Kenworthy, Charles F., Woodbury, Conn., U.S.A.
Kitching, Herbert Laurance, London.
Klein, Louis W., Chicago, Illinois, U.S.A.
Lal, Kanhaiya, B.A., Allahabad, India.
Lessing, R., Ph.D., F.C.S., London.
McLennan, Professor John C., Ph.D., F.R.S., Toronto, Canada.
Maconochie, Sir Evan, K.C.I.E., C.S.I., Seaton, Devon.
Mallinckrodt, E., Jr., St. Louis, Mo., U.S.A.
Muncy, Victor Emanuel, Cincinnati, Ohio, U.S.A.
Pollock, David, London.
Rees, J. Aubrey, London.
Rhodes, Aleck Leopold, Port of Spain, Trinidad, B.W. Indies.
Robinson, Dr. Leonard, C.B.E., Paris, France.
Rogers, Dr. Arthur William, M.A., Sc.D., F.R.S., Pretoria, South Africa.
Rollo, William Smith, Mandalay, Burma.
Singh, Sirdar Harbans, London.
Sinha, P. L., Cawnpore, India.
Starke, Robert Archibald, Herne Bay, Kent.
Vendelbo-Knudsen, Knud, Buenos Aires, Argentine.
Weidenbacker, Robert W., Haverford, Penna, U.S.A.

A paper on "Investigations in Agricultural Science at Rothamsted" was read by SIR EDWARD JOHN RUSSELL, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station.

The paper and discussion will be published in the *Journal* dated March 2nd.

PROCEEDINGS OF THE SOCIETY.

SIXTH ORDINARY MEETING.

WEDNESDAY, JANUARY 20TH, 1926.

SIR FRANK BAINES, C.V.O., C.B.E., Director of Works, H.M. Office of Works, in the Chair.

THE CHAIRMAN, in introducing the lecturer, said Dr. Morgan was the President of the Oil and Colour Chemists' Association and a Member of the Council of the Society of Chemical Industry. He had also been the Chairman and a member of various B.E.S.A. Committees, particularly the Committee dealing with the question of Ready Mixed Paints. That was a very controversial subject, and it would be interesting to hear from Dr. Morgan whether the operations of that Committee were going to prove fruitful or not. Some felt that it needed the optimism of the angels to believe that a thoroughly good ready-mixed paint would ever be obtained.

H.M. Office of Works was very vitally concerned with the subject of the paper. For example, it had to deal with the painting and the decoration of approximately 6,000 buildings, expending on that work an average of £300,000 per annum. It was quite clear that if, as a result of investigation into the problems of paint and varnish technology, only 10 per cent. of that expenditure could be saved, it would be a very large contribution towards national economy. Further, if it did, in fact, result in an economy to the Government, it would also result in an economy to the whole area of the work carried out in this country.

Another important point was that it was not often realised how vitally important was the quality of the paint. The reason he emphasised that was that the proportion of the cost of the material of the covering to the labour involved in putting on that covering was a variable factor. It varied, on work under the control of H.M. Office of Works, from one of material to three or four of labour, etc., to one of material to eight or nine of labour on certain big modern buildings. Therefore, any economy which would result from the improvement of the standard of the covering article would have very large results in view of the great economy it would make in the actual labour cost in applying that material.

The industry was being very seriously threatened, and its flesh had been made to creep, by the alleged utterances of Sir Frank Heath in Australia. Sir Frank Heath had there been speaking of a cellulose lacquer and a new type of varnish which was apparently going to sweep the industry completely off the face of the earth. Personally he did not think it need be anticipated that that was going to happen within the quoted period of ten years. If that period were multiplied by ten it might be nearer the mark.

Although he had had to deal with materials and paints for covering the buildings under his charge for a number of years, he felt that his ignorance about paint and its properties was absolutely abysmal. He did not know, for example, whether when a paint went wrong it was due to the pigment or the medium. He did not in the least know what kind of pigment one ought to put with a particular kind of linseed oil. He had not the least knowledge as to whether or not there was a chemical affinity between the pigment and the medium. That would show what an enormous ignorance existed amongst architects to-day on one of the most fundamental aspects of their work. But once a great industry began to recognise that it did not know everything it ought to know about its own business, usually,

if it were a good industry, it began to realise that it should acquire the knowledge which science said was so requisite. The first step in advance was to recognise that one did not know, and if as a result of Dr. Morgan's paper the industry found itself in a position to say that certain definite forms of enquiry were called for with regard to paints and varnishes, it would mark a great advance, not only with regard to the technology of the subject, but with regard to the question of the protection of the operative—which was a very controversial question. Personally he could not say whether the operative was detrimentally affected by the nature of the pigment, or whether he was detrimentally affected by the thinners and the turpentine substitutes which were used. Any fundamental research into the problems of the industry would probably not only be to the benefit of the industry itself, but to the benefit of the operative as well.

Dr. Morgan remarked that the B.E.S.A. Committee, to which the Chairman had referred, had been sitting now for two years. Whilst it had been possible to draw up certain specifications for certain straight linseed oil paints, it had very regrettably come to the unanimous conclusion that it was not possible to draw up specifications for the more elaborate types of paints—so-called gloss paints and enamels. The Committee had not the necessary information available.

The paper read was :—

PROBLEMS IN PAINT AND VARNISH TECHNOLOGY. THE NEED FOR EXPERIMENTAL INVESTIGATION.

By H. Houlston Morgan, Ph.D., B.Sc., F.C.S.

President, Oil and Colour Chemists' Association.

In order that the importance of the paint and varnish industry may be realised it appears to be necessary to emphasise the inter-dependence of all industries—the intimate and mutual relationships existing between them. The finished products of any one industry become the raw materials of many others. In this sense most, if not all, of our industries are " key industries," and it is a pity that individual trades, in order to concentrate public opinion as reflected in the daily press upon them, from time to time appropriate the use of this term as applying to a chosen few. Any such classification can only be one of degree and not of kind. It frequently resolves itself into assessing the magnitude of the ratio between the value of the so-called "key-industry" and the combined value of the industries which it feeds.

The total capital value of the paint and varnish manufacturers of Great Britain to-day is probably of the order of £15,000,000 and its annual value about £33,000,000. Industries which, under normal conditions, are more or less dependent upon the use of mixed paints and varnishes include the building and decorating trades, carriage, waggon and coach builders, the electrical industries, the manufacture of furniture, toys, tin boxes and containers of all sorts, cycles, automobiles, etc. The whole list is too lengthy to give in full, but enough has been given to show that the combined capital value of the industries concerned is out of all proportion to that of the paint and varnish industry itself. The above list does not take

into account the rubber, linoleum, and printing-ink trades, which are closely connected with the paint and varnish industry as regards the raw materials used and processes of manufacture.

Another aspect of the relative importance of the paint and varnish trade is obtained when we reflect that the main use of its products is as a protection against the corrosion of metals and the rotting of wood. It is difficult to estimate the value of the loss which would result from rust and decay if paint, or similar protective coating, were not used, but it may safely be put at not less than £100,000,000 per annum in Great Britain. Even with the quality and quantity of paint used to-day the loss due to rust and decay in the United States of America has been estimated at £6,000,000 per annum. It is interesting to speculate to what extent this loss might be reduced if better quality paint and more of it were used. It should be remembered that, although much has been written about the antiquity of paints and varnishes, their use as a means of protection against decay dates from not more than 200 years ago. Until that time there was little need for protective paints, but as economic conditions changed and civilisation advanced the need for preservation became essential and more and more insistent. It has been estimated that in the United States of America timber is now being used more than four times as rapidly as it is growing.

The methods used in the manufacture of protective paints and varnishes developed out of those originally used for making similar materials for artistic and decorative use. These methods were, for long, regarded as merely examples of a special kind of mixing and cooking, though, it is true, credit was given to the manufacturer for having developed considerable skill and art in his cooking and for being the possessor of certain secret recipes. The old-time craftsman and the recipe-worshipping manufacturer failed, however, to keep pace with the increasing demands made upon them for newer, cheaper and better products, with the result that the industry as a whole is in a backward position, and has much leeway to make up before it can lay claim to that degree of efficiency and rate of progress which are so essential for the welfare of Britain to-day. Though there is distinct evidence that, of recent years, modern scientific methods are becoming appreciated in the industry, it is to be feared that the natural British prejudice against "anything new" has delayed scientific development, with the result that the previously recognised superiority of British paints and varnishes in foreign markets is being vigorously assailed by American and German competitors. In order that this competition may be adequately met scientific research is as essential as advertising and sales organisation. The annual value of our export trade in paints and varnishes is about 3,000,000 cwts., so that if, for every cwt. exported, the sum of one farthing were contributed to a co-operative research fund, the latter would benefit to the extent of £3,000 per annum.

The paint and varnish technologist has to consider not only problems connected with the *manufacture* of paints and varnishes, but also problems relating to storage and keeping qualities, and problems connected with application. It is unfortunate that those engaged in manufacturing have paid so little attention to the keeping properties of their products and to the principles and methods of application. An intelligent and sympathetic understanding on the part of the manufacturer of the difficulties encountered by the user not only creates confidence and enables the right material to be supplied, but acts as a powerful stimulus to progress. Many manufacturers fail to progress because they do not keep in touch with the ever-changing demands of a rapidly advancing civilisation.

Paints and varnishes are generally regarded as being finished products, requiring merely to be " put on " to the surface which needs to be protected, obscured or decorated. It is more helpful, however, if we regard them as being " intermediate products " which, before they can perform any useful function, have to be converted into dried and durable films adhering to the surface on which the material is spread. The original paint or varnish is judged by the properties of this dried film, yet these properties depend not only on the stuff itself but to an equal, or perhaps an even greater, extent upon craftsmanship, and upon atmospheric and climatic conditions prevailing during application and drying. This lack of understanding, or want of appreciation, as to the complex and delicate nature of the changes that are necessary before the " paint in the pot " becomes the dried and durable film on the finished work, is a source of much annoyance, trouble and loss.

In order to solve the many and varied problems in paint and varnish technology it is necessary to have complete knowledge of the properties of our raw materials—pigments, oils, etc.—and to know the precise bearing which each of these properties has upon the economic value of the dried film. I use the term economic value to include not only the physical properties of the film, protective value and durability, but also the cost of application. It is well known that some paints require the expenditure of more time and energy in order to apply and renew them than do others, but this factor is frequently overlooked by paint technologists. When we reflect upon this ideal we are appalled by the paucity of our knowledge. Progress is being sadly handicapped through ignorance as to the properties of our raw materials and as to the changes that take place in them during manufacture, storage and use. There is crying need for intensive research and experimental investigation carried out with due regard to scientific method and principles. I make no plea for revolution and would urge that, in order to build well for the future, our present day technologists should have a sympathetic understanding of the past, and of the processes whereby the present methods have come to be. All honour is due to the old-time craftsmen, on the results of whose labour the paint and

varnish industry is founded. They were patient experimenters, carrying out true research. Owing to changes in economic conditions, however, their methods are now no longer permissible. The rate of progress necessary to-day is immeasurably greater than that of a generation ago, the cost of labour is out of all proportion to the old-time rate and the world-wide and keen competittion demand high industrial efficiency—low cost of production and high rate of output. Modern conditions demand that the factory should produce and not investigate. Research may or may not lead to the making of large profits, but it will assuredly help us to maintain our industry in a flourishing state, to revitalise it and keep it ever on the alert to absorb or reject, as the case may be, so-called " new-discoveries " and revolutionary ideas. Many such discoveries and ideas thrive on ignorance and at present we have not sufficient knowledge of the fundamental principles underlying the paint and varnish industry to assess their value.

Of the raw materials used by the paint and varnish manufacturer, linseed oil is one of the most important. Chemists classify it as one of the " drying " oils, and its drying property is said to be due to oxidation of unsaturated glycerides containing ethenoid linkages. Whilst it seems to be true that the *initial* change in the setting of a linseed oil film is one of oxidation, it is now becoming recognised that this is only one part of a series of complex changes that take place during the process. The tough, elastic, dried film does not consist of a homogeneous oxidation product called linoxyn, or even of a mixture of oxidation products—it always contains an appreciable quantity of liquid, unoxidised oil. The final process in the setting of the film resembles the setting of a jelly made of gelatin and water. The dried film probably has a cellular structure, resembling that of a honeycomb or sponge, the " framework " being composed of solid oxidised and polymerised products, whilst the " cells " are filled with fluid matter. Ideas as to the nature of this structure are, of course, highly speculative and perhaps somewhat fanciful, but, I think there is little doubt that the film possesses structure of some sort. One of the most important properties of paint and varnish films is that of adhesion to the surface on which they are put, and I regard structure in the film as being intimately connected with the property of adhesion. Attempts, therefore, to ascribe a chemical formula, or even a definite and universal composition, to a dried linseed oil film, are doomed to failure. Such a simple solution of the problem would be contrary to all common experience, and yet there have been many such attempts. Curiously enough also they have all been based on re-arrangements of the " acidic " parts of the glycerides in the oil; the part played by the glyceryl radicle has been inexplicably neglected, notwithstanding the known facts that neither the fatty acids nor their ethyl esters set to a tough film on oxidation.

It is well known that the rate of drying of linseed oil films is enormously

affected by heat, light, moisture and the presence of even minute quantities of other substances. But it is not generally recognised that when linseed oil dries under these varying conditions the resulting films vary both in composition and in properties—including durability. The *modus operandi* of the " setting " is altered and the resulting product is different. These facts are of the utmost importance when considering the vagaries of paint and varnish films which have been applied and dried under different conditions. They also have a distinct bearing upon the many vexed problems connected with the evaluation of paints and varnishes, either by means of exposure tests, or by the determination of various physical properties of their films which have been dried under *standard*, though arbitrary, conditions. So frequently in this connection a prediction based on the results of laboratory tests does not conform to that borne out by practical usage. It does not follow, however, that laboratory work should be condemned; rather should there follow increased activity in scientific research for the necessary knowledge which would prevent inaccurate conclusions being based upon insufficient evidence. Such faulty predictions are due, not to " fate," " evil spirits," or other factors beyond our control (which is a typically English view) but to lack of such knowledge as is within our power to possess. The probable sequence of changes involved in the setting of a linseed oil film may be given as, oxidation, condensation, polymerisation and gelation, but the causes and effects of these various changes require searching investigation, as also does the effect produced upon each *part* of the process by the variation of external conditions.

A dried linseed oil film possesses very little durability when exposed to the weather, and is seldom used alone as a protective coating. During the earlier part of its life it remains moderately soft and is not hard enough to withstand abrasion by knocks, blows, beating rain, etc. Moreover, it absorbs water freely and readily emulsifies—as is shown by the well-known whitening or milky appearance in wet weather. As the life of the film increases it becomes harder, but it also undergoes changes in volume which cause it to crack. I should, perhaps, point out that my remarks refer to films obtained by " drying " at normal temperatures, with or without driers. If linseed oil be dried at temperatures of 150° C. or 200°C.—either by stoving or by application to hot massive iron—then very durable and hard films are obtained. There is no doubt, however, that the constitution of the films so obtained is entirely different from those obtained by drying under normal conditions. When linseed oil, in bulk, is heated to temperatures of 200°C. to 300°C. a certain amount of decomposition takes place and it gradually thickens. The process is spoken of as polymerisation, but the changes that take place are obscure and need investigation. Films of this oil are slower drying than those of the original linseed oil, but have a longer life on exposure. This increased durability of the dried film of polymerised oil may be correlated with—(i) reduced per-

meability to water, (ii) diminished tendency to absorb and emulsify with water, and (iii) smaller changes in volume during the ageing of the film.

China wood oil, or tung oil, is the drying oil which stands next to linseed oil in importance. The changes that take place during the drying process appear to be somewhat similar to those that take place during the drying of linseed oil, but there are important differences which may be traced to a difference in composition. The presence of moisture in the air, and possibly also of other substances, profoundly affects the rate of setting and the quality of the dried film. The latter is more durable than that of linseed oil, being harder, tougher and less permeable to moisture, absorbing water less freely and showing comparatively little tendency to emulsify. Unfortunately the dried film usually has either a "ground glass" appearance, being opaque and frosted, or is semi-transparent and wrinkled. A mixture of polymerised linseed oil and polymerised tung oil gives a more durable, clear and glossy film than does either oil alone—raw or polymerised.

An all-oil film does not make an acceptable varnish. It is undoubtedly too soft for indoor use, as it never really hardens under such conditions. When used out of doors it is inclined to lose its gloss very quickly. It is unfortunate that the taste of the public is so garish that it demands paints and varnishes having a high, lasting gloss—the attainment of such gloss is obtained in many cases only at the expense of durability. Harder films having a more lasting gloss are obtained by the incorporation of resins with the oil. During this process in the manufacture of varnishes polymerisation of oil takes place together with some, even more obscure, change in the nature of an irreversible combination between oil and resin. The resulting mixture is, unfortunately, too thick to be capable of easy application, and is thinned by the addition of a volatile thinner or solvent. The presence of this solvent introduces still further complications into the already complex process of the setting of an ordinary oil film.

It is quite commonly stated that, since the volatile solvent in a varnish completely evaporates, it can have no effect on the properties of the dried film left behind. Yet the effect of solution on the crystalline form of solids deposited from it is well known and is readily illustrated by the simple case of amorphous sulphur dissolved in carbon-di-sulphide. When the solvent is allowed to evaporate the sulphur is deposited in the form of diamond-shaped crystals; the solvent has brought about a change in the structure of the sulphur. In the case of varnishes, however, we are dealing with what are called emulsoid colloid solutions where the effect of the solvent is much greater than is the case with crystalloid solutions such as sulphur in carbon-di-sulphide, and where there is a much more intimate relation between the properties of the solution and the properties of the "solid" left behind after evaporation of the solvent.

It is my opinion that in every instance where a liquid or solution yields a

coherent, firm, bright film on drying, gel formation takes place during the "setting" process. Even in the case of shellac, where it might be supposed that solutions in methylated spirit approached molecular dispersions, it must be remembered that these solutions become concentrated during drying, and, in all probability, pass through the gel condition before becoming finally dry—just as, in the reverse process of dissolving shellac in methylated spirit, the former first swells to a gel before it dissolves to produce the well-known shellac solutions. This process of "jelling" which takes place during the "drying" of all paints and varnishes, indicates that the film must have some sort of structure,—honeycomb, lattice-work, cell-like, illustrate it how you will. Moreover, the character of this structure depends upon the *properties of the solvent*, and is governed by the character of the solution—the way in which the particles or aggregates are dispersed throughout the solvent. These particles could not have an entirely independent existence, roaming throughout the whole solution. Their movements must be restricted by structure of some sort in the solution itself. The structure existing in the fluid varnish largely controls the structure of the film, and the latter structure, in turn, largely controls the durability, etc., of the film. It should not be too difficult a task to correlate the physical properties of the solution, or varnish, with the physical properties of the dried film. This relationship went to the root of things and there would be a very real advance towards being able to predict durability if its value were known. Some idea as to structure of solution, type of dispersion, etc., can be obtained by determining the degree of fluidity or viscosity of varnishes; the way in which viscosity changes with temperature and with rate of shear gives very useful information. There is need for much research work on these points.

Speaking in general terms, the quicker drying varnishes, rich in resin content, show greater changes in viscosity on account of temperature changes than do those rich in oil. The viscosity of a varnish should be considered in relation to the percentage of volatile solvent it contains. A varnish containing an abnormally high proportion of volatile solvent generally shows a large change in viscosity with change in temperature. These points are also important when considering the brushing and flowing qualities of varnishes. It is, unfortunately, quite common to find people arguing that, since two or more varnishes have been found to have the same viscosity at a definite temperature (e.g. 20°C), therefore they should behave similarly under the brush in the hands of a painter. There are three points to be considered in this connection :—

(i) All varnishes have not the same temperature co-efficient as regards viscosity, so that unless the varnishes are used at 20°C. they need not possess equal viscosities at the temperature of application. This point is of importance when comparing the results obtained by different varnishes used under varying climatic conditions.

(ii) most of the volatile solvent in a varnish evaporates during the first five or ten minutes after application, so that as the painter works his varnish its viscosity is gradually increasing. For similar ease in working (particularly in relation to " picking up the edges " on large panels and going back on to the work to " pick up runs ") the viscosities of the non-volatile portions of the varnishes should be approximately equal. Varnishes in which the non-volatile portion is too viscous are generally referred to by the painter as being " too quick drying," and the fault is usually attributed to the presence of too much driers, but, in most complaints of this kind, the question of driers does not arise, the effect being noticed long before oxidation has had time to make itself felt. Ease of application is sometimes obtained at the expense of durability and in order to get the best results a compromise is necessary.

(iii) there is probably some other property in addition to that of viscosity as ordinarily determined which affects the " working " under the brush, and which a good craftsman instinctively feels from long experience. This other property is bound up with the question of structure and plasticity and requires further elucidation. At present the only way in which this has been investigated is to find the variation of viscosity with variation in the rate of shear.

The changes which take place in the viscosity and structure of varnishes with time during storage should also be investigated. In some cases the changes are beneficial, resulting in a varnish which works more freely; such changes are spoken of as " ageing." In other cases thickening or " fattening " or even "jelling " takes place, without any change in the content of volatile solvent; such changes are a nuisance. It may be interesting here, perhaps, to mention that the smallest difference in the viscosity of oil varnishes which a skilled craftsman can readily detect with his brush corresponds to about 0.5 poise; equivalent to a difference of between 1 and 2 per cent. of volatile solvent in an average varnish.

Before putting one coat of varnish over another it is usual to " rub down " the dried undercoating varnish with pumice powder, to a dull, matt, smooth surface having a slightly frosted appearance. There is a widespread opinion that such a flatting process is necessary in order to get proper adhesion between the two coatings. In certain cases the adhesion is probably improved by such flatting, but in the vast majority of cases where the second coat is applied within two or three days after the application of the first coat—and particularly when the varnish is well worked with the brush—proper adhesion is obtained without rubbing down. The main reason for the " flatting " process is, as its name implies, to obtain a flat surface free from pimples, wrinkles and such like irregularities. No air-dried varnish gives a film at all comparable in smoothness or flatness, to that of a polished surface. Moreover the irregularities of one

coat are *not* levelled out, or filled in, by the second coat applied over it. On the contrary they become very much more accentuated, so that, in order to avoid this accentuation it becomes necessary to rub down the first coat. The *rôle* of the solvent in contributing to the property of adhesion between oil varnish coatings is frequently overlooked. Although dried varnish films do not *dissolve* in the volatile solvents generally used, such as turpentine and white spirit, the latter are *absorbed* by such films as have not undergone protracted oxidation. During the process of absorption the films swell slightly and become somewhat softened, just as cold water is absorbed by gelatin though the latter may not dissolve in it. This change in the previously-set undercoating enables a certain amount of inter-penetration of the two super-imposed films to take place and very materially assists adhesion. Turpentine has a greater softening action than white spirit, and the increased tendency to "cissing" or poor adhesion which may reveal itself by the use of varnishes containing certain types of white spirit is more often explained by a difference in softening action than by the presence of "greasy matter" in the white spirit.

The comparatively slight, though distinct, softening action of one coat on another, is one of the outstanding features of drying-oil coatings, and one in which they show to great advantage over spirit varnishes and lacquers, where the non-volatile part of the film does not change in solubility during the process of drying. In such like lacquers the effect of the solvent on the undercoats is often so great that the adhesion of the first coat to its support is seriously weakened.

It frequently happens that a varnish film which has been flatted, or rubbed down with pumice, becomes glossy again after a time; such a phenomenon is referred to as "sweating." It is evident that the film, either wholly or in part, was not rigid enough, but that flowing has occurred. Either the softer portions of the film have flowed in to fill up the hollows of the scratches, or, the "walls" of the scratches have themselves flowed downwards and outwards. Both types of "sweating" take place and it is important to distinguish between them as they indicate the cause of the sweating and how it may be remedied. Sweating is not a serious fault in itself and the varnish need not again be flatted; on the other hand, sweating under certain conditions may indicate an unsuitable varnish.

In considering the subject of paints, I wish at the outset to emphasise the interdependence of pigment and medium, or vehicle. It would be well nigh impossible to over-estimate the troubles and misunderstandings that have arisen, in all sorts of ways, through chemists, technologists and others neglecting to take into consideration the part which the medium contributes to the properties of a dried paint film. It is perhaps unfortunate that, in many quarters, dry pigments are classified and referred to as paints instead of as "paint ingredients" or some such term. It is well known that the colour

and opacity of pigments vary according to the refractive index of the medium in which they are incorporated. Yet, when investigating changes that take place in the colour of paint films, this fact is often overlooked. Fading, and other colour changes, are frequently due, not to changes in the pigment itself, but to a change in the optical properties of the paint as a whole brought about by changes in the *medium*.

I can illustrate this by the commonest and simplest case where the medium weathers and disintegrates, so that the continuity of a highly-refracting surface, in which particles of pigment are embedded, ceases to exist. A similar result is obtained by abrading the surface and producing a ground-glass, or frosted, effect. In these cases a greater proportion of diffusely-reflected white light is obtained and the change of colour is mainly one of " tone," i.e., the change that would be produced by mixing white pigment with the original paint. The addition of " white " to certain colours, however, also alters their " hue," e.g., certain greens become more blue and less yellow on being thus reduced. The common defect which brunswick green paints have of becoming a chalky-blue on exposure, is due in most cases almost entirely to weathering and disintegration of the medium, and not to fading of the pigments used. They may be restored to their original colour, or nearly so, by brushing them over with oil or varnish. This defect is the more pronounced the greater the proportion of Barium Sulphate, or similar material, which lacks opacity or whiteness in the smooth intact film, but which shows up white when the medium has become disintegrated by weathering.[1] Similar remarks apply to paints made from lake reds precipitated on Barium Sulphate, etc., though in this case the defect is sometimes accentuated by a *partial* fading of the pigment itself. Lack of appreciation in this connection of these well-known elementary facts has led to the unwarranted condemnation of many pigments and to protracted, expensive and abortive searches for pigments with impossible qualities instead of quests for more permanent mediums; thus showing the need for a proper diagnosis of the trouble before attempting to apply a remedy.

An illustration of the all too common view of endowing a paint film containing a particular pigment with the properties of the pigment itself is shown by the following quotation from a recently published text book on " Oil and Colour Chemistry." It is stated therein that " Graphite is said to be useful in a paint because of its fireproof properties," and also that " Graphite imparts immunity against the corrosive action of gaseous sulphur compounds, ammonia, the halogens and their gaseous derivatives, etc." Graphite paint undoubtedly has its uses, but it can scarcely be called fireproof, nor is it the panacea for all the evils of corrosion in a chemical laboratory or works that the above statements would suggest. Again, one frequently comes across references to the use of asbestos in making a fireproof paint, thus suggesting the inferences that, firstly, the usual pigments are combustible, and secondly, asbestos renders linseed oil

(1) these points were illustrated by experiments.

non-combustible. Even barytes and powdered slate are recommended *because* of their stability in a moisture and acid-laden atmosphere. These materials are undoubtedly extremely useful paint ingredients for certain purposes, but the exact way in which they function and contribute to the desired qualities of the paint is at present unknown. It certainly depends upon something more than insolubility in water and acids. The various pigments in use obviously have inherent qualities which confer specific properties on the paints containing them. But the properties of a dried paint film must of necessity be a composite effect, and can in no sense be identical with those of a single ingredient in the form of loose independent particles. Moreover, far too much attention has been paid in the past to the chemical composition of pigments, to the neglect of their physical condition.

Extraordinarily divergent views exist regarding the utility and economic value of the various pigments, but these opinions are backed by very little evidence of a convincing character, either practical or theoretical. This state of affairs may, in large part, be attributed to the following reasons :—

(1) neglect to consider the *rôle* of the medium,
(2) attempts to correlate the value of the pigment with its chemical composition only,
(3) lack of knowledge concerning the influence of size of particles on the properties of a pigment,
(4) lack of knowledge regarding the relationships between, and methods of measuring, the fundamental properties of a pigment, viz., size and shape of particles, oil absorption, staining power, opacity, colour.

Information regarding these fundamental principles is urgently required and would not only lead to increased confidence between manufacturer and user, but would ensure higher industrial efficiency to all concerned. It would enable the manufacturer to improve and maintain the quality of his products and to reduce the cost of production ; it would enable the user to test his paints in a reasonable time and in a satisfactory manner without having recourse to lengthy or large scale exposure tests.

Although it is essential that the properties of the pigments themselves be first studied, it is, of course, equally necessary to investigate these properties in relation to the various paint mediums—to ascertain how they are modified by the medium itself and by the process of mixing. The manner in which the medium modifies what might be termed the " texture " of a pigment, or the " effective size " of its particles is a subject of far-reaching importance, and one which would amply repay intensive investigation. The so-called grinding and mixing of dry pigment with medium in order to produce a paint requires the use of expensive grinding machinery, absorbing much energy but having a low rate of output. This grinding process is necessary, not to crush or break down individual particles of pigment, but to break up aggregates or clusters

of dry particles, to bring about a complete "wetting" of every individual particle and to ensure their complete dispersion throughout the medium. The complementary properties of wetting and dispersion depend upon mutual reactions between medium and pigment. Any change in the chemical composition or physical condition of either component may modify these properties.(2)

The setting of paint films is a problem urgently requiring very detailed investigation. The changes that take place during the drying and setting of straight linseed oil paints must not be assumed to entirely resemble those taking place during the drying of a linseed oil film alone. The introduction of pigment profoundly modifies these changes; in some cases, such as the setting of putty and other oil-pigment pastes, their character may be entirely altered. Detailed investigation is required into the action of each individual pigment —including those misleadingly called inert—towards linseed oil. We require to know their effect upon the oxygen-absorption of linseed oil, upon polymerisation and upon gelation; also whether any changes or troubles are caused by adsorption and by chemical action between pigment and oil. Surface forces between oil and pigment particles come into play and are of such enormous value that it is difficult to assess them. The idea, sometimes expressed, that linseed oil acts as a sort of cement binding all the particles together is not a bad one provided that the mutual action of "cement" and particle be not lost sight of. The strength of the union will vary not only with the type of material of which the particle is composed (white lead, red oxide of iron, barytes, etc.), but also with the size and shape of the particle, and with the thickness of the layer of "cement" between the adjacent particles—in other words upon the state of "packing," and the concentration, of the pigment particles in the oil.

The problem of fixing the relative proportions of linseed oil to dry pigment in a mixed paint so as to yield the most durable product is a very important one. It is generally recognised that there are certain limits between which the concentration of pigment must be in order to give the best result—though it is difficult to get people to agree as to the values of these limits. For simplicity in exposition we may refer to the mean value of these limiting concentrations as the optimum concentration. It is also well known that the value of this optimum concentration varies according to the pigment used. But the fact is so frequently overlooked that it depends upon size and shape of particle and degree of dispersion throughout the oil as well as on the chemical composition or specific nature of the pigment. These are also the factors which govern the "consistency" of the mixed paint in bulk, and if some satisfactory way of measuring the consistency of mixed paints could be agreed upon, then one of the main difficulties in specifying and predicting the durability of ready mixed paints would be surmounted. This is a problem on which a certain

(2) this was illustrated by experiments.

amount of comparatively recent research work has already been published. The method of attack is to determine the way in which the rate of flow of the paint alters when the force or pressure causing that flow is also altered.

The durability of a paint depends to a large extent upon its opacity. Paints containing only pigments such as barium sulphate, china clay, whiting, etc., which are nearly transparent in a linseed oil paint film, possess little durability. Materials such as white lead, red oxide of iron, lead chromate, etc., all possess opacity under similar conditions and it is known that the presence of these true pigments confers durability upon a paint containing them. It seems to be true also that durability is related to the colour of the pigment (irrespective of its chemical composition) and to the behaviour of the latter towards ultra-violet light. Nevertheless there seems to be overwhelming evidence to the effect that the durability of a paint is more intimately related to the chemical composition of the pigment than merely indirectly by its action on the sun's rays. Whether this relationship takes the form of any ordinarily recognised type of chemical action between oil and pigment or whether it is due to some more subtle physical action is not known. It is generally recognised, however, that paints containing such substances as white lead, zinc oxide, ferric oxide, etc., owe their durability in part to the peculiar chemical relationship between these compounds and linseed oil. I wish particularly to emphasise this point, because, of late, the re-action to the all-chemical view of assaying a pigment seems to have gone to the other extreme in certain quarters, and we are told that chemical composition does not matter. Particularly is this so with red oxide of iron pigments. Whether a rough proportionality exists between the durability of a paint and its ferric oxide content—when comparing red oxides of equal fineness and oil absorption—is not known and it seems unprofitable to speculate thereon in the light of such conflicting evidence as is available. There is no doubt, however, that there is a limit below which the ferric oxide content should not fall in order to get a durable paint. Is this limit set by the opacity of the paint or other optical property of the pigment? Probably not, in my opinion, but the whole question needs investigation and, in view of the fact that the naturally occurring deposits of red oxide of iron pigments in Great Britain are of lower ferric oxide content than many imported pigments, its national importance is thereby the greater

Straight linseed oil paints containing the optimum concentration of certain pigments such as white lead, red oxide of iron and many others, possess very considerable durability and have much to recommend them if considered only from a protective point of view, but they are deficient in decorative value. They do not flow out well and lack that smooth even surface which simulates enamelled or polished surfaces, and which, in addition to the enhanced appearance, is more easily cleaned. They are also rather prone to changes of colour due, in some cases, to the easy lodgment of dirt, etc. to the comparatively rough surface or, in other cases, to the "fading" action of light either on the pigment itself or on the medium.

In order to remedy these defects some people recommend the use of varnish over paints. In certain cases such a method of procedure is, perhaps, justifiable, as, for example, when using a bright-red which is not too fast to light. Then, in other cases, where a coat of varnish can be given at comparatively frequent intervals without entailing much cost for labour and scaffolding, etc., there may not be much to be said against it, but in many cases the application of the varnish is a waste of money and a fruitful source of trouble when the time for repainting occurs. It must be remembered that no varnish can in any way compare in durability with a good straight linseed oil paint. It is true that a coat of varnish will preserve the general fresh appearance of the paint for a few months, but when, at the end of this period, the varnish begins to perish, becoming cracked and friable, chalking, and flåking, the appearance is often far and away worse than it would ever have been had the varnish not been applied.

If, instead of applying paint and varnish in separate coatings, they be mixed together and the mixture applied in single coatings, a much better result is obtained. The varnish improves the decorative value of the paint and the pigment improves the durability of the varnish. It is possible to manufacture paints of this character which yield films that are more durable and more pleasing in appearance than those obtained by the use of straight linseed oil paints, either alone or when varnished over. Paints of this class—which combine good durability with high decorative value—are generally referred to as gloss paints or enamel paints. It is a matter for confusion amongst many people as to what governs the difference between a paint and an enamel, and also as to when a gloss-paint becomes an enamel. There is, of course, no hard and fast system of classification; each class gradually merges into the other. Speaking generally, we may say that paints combine a high concentration of pigment with a non-volatile medium of low viscosity whilst enamels combine a low concentration of pigment with a non-volatile medium of high viscosity. The enamel will contain more volatile thinner than the paint. As a result of this difference in composition paints possess higher opacity than enamels and work more easily under the brush. On the other hand their dried films are uneven and less pleasing to the eye when compared with the smooth even surface of an enamel. The deficiency in gloss of the paint film is mainly due to the unevenness of its surface,

Gloss paints are attempts to combine the good qualities of both paint and enamel with the elimination of their bad qualities. A good gloss paint should work freely under the brush, have good opacity, and yield a smooth, even, moderately glossy film. Usually it is more durable than either paint or enamel. Its gloss may not be so high as that of an enamel and, in some cases, it may lose its gloss during the first few months of exposure more rapidly, but, in the long run, the gloss paint will exert its superiority. Unfortunately, gloss is made too much of a fetish. Smoothness and evenness

of surface are the qualities to be aimed at; surfaces which can be easily washed over and which, after such treatment, show up as good as new. There seems to be both upper and lower limits to the degree of gloss which it is advisable to have in order to obtain a paint of maximum durability.

There are a large number of complicated problems, relating to the subject of gloss paints, which need investigation and elucidation. On the manufacturing side particular attention should be paid to the fineness, purity and dryness of pigments, and to the relationships between pigment and medium, which will enable the former to be readily and permanently dispersed throughout the latter—more expeditiously and economically than at present—with the production of a stable paint showing no tendency to flocculate, "fatten" or "cake." It is essential also that the user should be able to assess the probable durability of the paint he buys. He is severely handicapped in this respect because, on the one hand, there is no reliable and accurate method whereby the paint may be analysed into its essential component parts and, secondly, even if it were possible to make such an analysis there are not in existence sufficient data to show the relationship, if any, between the results of a chemical and physical analysis and the durability. This represents the unanimous conclusion recently arrived at by a comprehensive committee of the British Engineering Standards Association set up to consider the drafting of specifications for gloss paints. This committee has found it impossible to proceed pending the results of an extended investigation.

In order to obtain such data a large number of paints—of variable durability—should be submitted to exposure tests and also, at the same time, to chemical and physical examination in the laboratory. At the end of two or three years it should be possible to correlate the two sets of results with a view to determining on which properties of the paint the durability depended and the mathematical value to be assessed to each of these properties in order to get maximum durability. Exposure tests of various kinds have been carried out from time to time, both in this country and abroad, but in nearly all cases their object has been to compare the value of *pigments* and to correlate the durability of a paint with the chemical composition of the pigment it contains. In the few cases where some attention has been paid to the medium and to pigment concentration, the object aimed at was to show some connection between durability and the *ingredients used in the preparation of the paint.* The object I have in mind is quite distinct from either of these, viz., to find out some relation between durability and *such properties, of a mixed paint, as may be readily determined in a laboratory.*

It is not suggested that exposure tests can take the place of practical experiences which have taken years to accumulate. The snares and pitfalls encountered when trying to substantiate generalisations laid down as a result of limited experience are only too well known. With gloss paints, however, there is no large accumulation of experience or data available, and, where such

do exist, there is no laboratory work with which to correlate them, so that there is no means of proving that a second batch of paint is of equal quality to that previously used. The value of exposure tests lies partly in the fact that they are less costly, both in time and money, than large scale practical jobs, and partly in the fact that the paints may be compared when applied under similar and standard conditions. At the same time it is eminently desirable that the same paints be tried under variable conditions of application and exposure and on actual large scale operations. As regards the laboratory work, it is important that the properties of the paints in bulk be investigated—particularly in connection with "consistency," rate of change of viscosity with temperature, with rate of shear and with time. It is equally necessary that the properties of the dried films be studied and methods devised whereby such properties as gloss, opacity, hardness, flexibility, tensile strength, water absorption and adhesion may be measured. Various laboratory tests of this kind have been proposed from time to time, but sufficient attention has not been paid to the fact that the properties of the films which we wish to measure are continuously changing—especially during the first few weeks of their life—also that they depend upon the atmospheric conditions such as temperature, light, humidity, etc., prevailing during the drying period. Properties of films should be investigated therefore on films of different ages and on films dried under various conditions. It will probably be found that it is the *rate* of change of these properties which is more intimately related to the durability of the film than is the absolute value at any arbitrarily fixed age.

DISCUSSION.

MR. A. SELBY WOOD (President, National Paint Federation) said he was sure the audience would agree that Dr. Morgan had abundantly made clear the case for the necessity of further knowledge and research in the industry. Many were inclined to think that they had enough to do to look merely at those matters which were within the confines of their own particular business, and to consider only their own particular problems, but the subject should be looked at not only from the national aspect but from a world-wide aspect. He thought he would be well within the limits of truth when he said that certainly before the war, despite what might have happened in connection with other British industries, the paint, colour and varnish industry of this country, in so far as the world trade was concerned, was in the proud position of being in the leading place in the world. In the great export markets of the Far East, of the Americas—South America particularly—and elsewhere, it was beyond doubt that British products were preferred and bought to a larger extent than those of any other nation. During the war that position had been attacked for the first time, mainly for the reason that there had been a stage where exports had had to be very strictly rationed, both on account of the carrying capacity of ships and the difficulty of getting raw materials and labour in this country. That had been an opportunity for foreign competitors, and the Americans in particular had taken full advantage of that opportunity to get a footing in markets where they had had practically no footing before. He mentioned that because it seemed to him to be one of the most important points in relation

to Dr. Morgan's paper. If they in the paint, colour and varnish industry were to retain the position they had held in the past, it behoved them to be up and doing, especially in view of the world-wide competition not only from America, where a great deal of research was being carried out, but also from other countries where, too, research was also being carried out.

Personally, he was very proud of the fact that the industry was still in a very high position, and he ventured also to be proud of the attitude and record of the members of his Federation towards the question of research. Perhaps it was not generally known that when the matter was first brought to the Federation's attention, in the very late months of last year, two schemes had been placed before them. One was a comparatively small scheme, although it involved a considerable amount of money being put up by the trade, and the other was a more ambitious and larger scheme involving more than double the amount of the smaller scheme. When the latter scheme had first been mentioned there seemed little hope of getting it going, but within the space of a month it had been over-subscribed. The Federation then took heart, and they felt that they might make an effort to see how far the larger scheme could be tackled, and he had the great pleasure of announcing that they were now well within sight of the amount required for the larger scheme, and it seemed almost certain that they would be in a position in the course of a very few months to say that they were going ahead with it.

The large meeting that night, representing as it did a very large user of paint in the person of the Chairman, manufacturers and the technical side of the industry, was to him a very hopeful portent of the future progress of the industry.

MR. C. A. KLEIN said the paper was a very remarkable one. After reading it, he had tried to imagine anyone reading such a paper 20 years ago; and he was inclined to think it could not have been written. A paper on the subject 20 years ago would have been much more emphatic and dogmatic, and at the same time probably almost entirely wrong. Dr. Morgan had approached the whole of his subject with a humility which was characteristic of deep knowledge. Possibly Dr. Morgan's grandson in another 50 or so years would be able to dogmatise correctly on this subject.

From the point of view of the chemist, he pleaded to the manufacturers to make openings in their businesses, works and laboratories, which would make the paint and varnish industry attractive to chemists. If they did not do that they would not draw in the best type of men; they would only get what they paid for.

On page 281 Dr. Morgan said, "Moreover, far too much attention has been paid in the past to the chemical composition of pigments to the neglect of their physical condition." Then on page 283 he said, "I wish particularly to emphasise this point, because, of late, the reaction to the all-chemical view of assaying a pigment seems to have gone to the other extreme in certain quarters, and we are told that chemical composition does not matter." Might he (Mr. Klein) take it that it had been over-done, and that Dr. Morgan was now pleading for a mean?

DR. MORGAN replied in the affirmative.

MR. KLEIN said with regard to the author's remarks about the temperatures which the pigments would stand, he had had a pigment offered to him last week which he was told would make a paint which would stand a temperature of 1,760°C. The only explanation he could get was that the melting point of the actual pigment itself was 1,760° C. The melting point of the oil or the medium was not disclosed!

With regard to the author's remarks on the size and shape of the particles, he hoped that Dr. Morgan would drive it home to the mind of the average paint

technologist that the particles of a paint were not, as they were usually supposed to be, entirely spherical. It was a huge mistake to imagine, as they did, that all those particles were spherical and that they all obeyed Stokes' law. As a matter of fact, the bulk of them were not spherical; many were laminated, and there was no relation between Stokes' law and that particular shape. All that had a great bearing on the question of dispersion which Dr. Morgan had so very rightly stressed.

MR. S. K. THORNLEY (Chairman, Research Committee, National Paint Federation) expressed the hope that when the paper was published the title should be altered to, "A Plea on Behalf of Research in connection with the Paint and Varnish Industry." As Chairman of the Committee which was endeavouring to get the necessary money, he looked upon Dr. Morgan's paper as the finest piece of propaganda possible. He had had certain difficulties in approaching manufacturers in regard to the matter. He occasionally came across a spirit of lukewarmness in manufacturers, who either were content with the embalmed knowledge of the past or who looked upon research as merely a distribution of knowledge amongst the general public which would only result in bringing forth further competitors for themselves. He was confident that that very narrow view would disappear, and that before very long the industry would possess one of the finest Research Associations in the country.

As a varnish maker, he regretted Dr. Morgan's remarks about varnish. In spite of what Dr. Morgan said, it was a fact to-day that there was not one in a thousand motor cars, railway carriages or tramcars in this country that was not finished off with a coat of varnish on top of the paint, despite the fact that in many cases the paint used was a species of gloss paint. It was interesting to know that when a gloss paint had perished, all that was necessary to restore it to its original colour and appearance was a coat of good varnish.

Dr. J. J. Fox said that he and others had urged the necessity for research in paint and varnish for many years. They had not been satisfied to assume that the progress made in paint and allied products was the last word. It was satisfactory to learn that chemical investigation of paint was still considered an advantage. There was no great difficulty in the examination of a straight run oil paint, particularly when associated with some inquiry into the nature, size and shape of the particles of the pigment. The position was different with varnish or gloss paints, and the difficulty here arose largely from the absence of adequate information as to the chemical and physical changes undergone by the gums and oils in making the varnish. To take a less complicated case; the manner of drying of an oil was not properly explained by any theory so far advanced. We did know that in the absence of certain properties an oil would not dry, but not a great deal more. Again, the reason for certain pigments requiring less oil than others was not properly understood. What really happened when gums were broken by cooking and then compounded with oil? How could one obtain even better paints than those now produced, and how could it be established beforehand that any given paint is likely to be durable? The answer to such questions can only be got by research.

One useful work ready to hand would be to clear the ground of erroneous notions concerning the nature and properties of certain pigments and media and their behaviour in varying conditions. Such information could be made available for the industry and for users through the medium of a publication of the character of the "Journal of the Oil and Colour Chemists' Association," without very much

additional cost. The speaker called attention to the continuous output abroad of the results of investigations in paint and varnish, implying substantial expenditure of time and money on research. It was true that much of this output did not lead far, but even if a small percentage of the work now being done pointed the way to technical inprovements the expenditure would be amply repaid. He would like to express his appreciation of the spirit in which the leaders of the industry regarded research on fundamental matters.

MR. NOEL HEATON said he thoroughly agreed with Mr. Thornley that the paper might well be entitled "A Plea for the Organisation of Systematic Research on Paint Technology." That was a subject which for many years had been dear to the heart of every progressive paint chemist. It was now nearly 20 years ago since it began to dawn on a few chemists connected with the paint industry that there were a good many problems connected with their work which required investigation; and they had formed an organisation known as the Paint and Varnish Society, for the purpose of exchanging views and of trying to stimulate investigation of those problems. It had been a very difficult task in those days. For one thing, he did not think most paint manufacturers realised then that there were any technical problems to be overcome, and when that little band of enthusiasts to whom he had referred had suggested to the manufacturers that they should combine together in order to investigate the problems of the industry they had always been met with two difficulties. When they had gone to the manufacturers in times when trade had been brisk and when everything had been going smoothly, they had been met with the reply: "Yes, we quite agree with the idea, but we are far too busy now to go into the matter;" and when they had gone along in times of depression they had been received with: "Yes, we have got plenty of time now, but trade is so bad that we have not got any money." The result had been that progress had been slow for many years, but in recent years, particularly in the last two years—largely due to the initiative and enterprise of Dr. Morgan—things had begun to change, and now, as had been mentioned that evening, the industry was practically within sight of the goal towards which many of them had been striving for all these years.

The paper contained an enormous number of valuable suggestions for research which could only be undertaken in a systematic manner and by combined effort. Such conceptions as Dr. Morgan had put forward—as to the structure of the oil film, and the influence of solvents on the paint film, and so forth—were matters of fundamental importance, but they were far too complicated and difficult for investigation by any individual concern. That was why a plea for a systematic research was of such great importance. For instance, take the case of the action of solvents. Dr. Morgan had made some very illuminating remarks about the influence of different solvents on the paint, and he had contributed some valuable points to that hotly-discussed question of the value of petroleum spirit as a thinner as compared with turpentine. That raised, further, the question as to what really was the action of organic solvents on oils, and particularly on resins. Personally, he felt very ignorant as to exactly what took place, and thought it would form a profitable subject for research.

There was a good deal of evidence for thinking that the action of a substance like turpentine on a resin was not really a case of solution at all, but presumably a gradual dispersion of the solid in the liquid, the particles of solid becoming so small and the difference between their refractive index and that of the liquid being so slight that they became invisible.

Again, Dr. Morgan's remarks were very valuable on the question of the inter-dependence of the pigment and the medium, and he endorsed strongly everything Dr. Morgan had said as to the extraordinary confusion of thought which there was amongst so many people as to the relative functions of the pigment and the vehicle in a paint. He had come across that constantly in connection with the subject of the permanency of pictures. Periodically people wrote to the papers drawing attention to the fact that modern pictures were not lasting as well as the paintings of the old masters, and the correspondence always wound up with the question, "Why do not artists and scientists combine to find out the secret of the old masters as regards the durability of their pigments ?"

In most cases, however, the comparative failure of modern pictures was due, not so much to any lack of permanent pigments, as to the mediums used, and to lack of craftsmanship, or knowledge of the technical principles and processes involved in painting.

At the same time Dr. Morgan had clearly brought out the fact that one should not rush to the opposite extreme and argue that because the durability of paints was largely dependent on the durability of the vehicle, the pigment had nothing whatever to do with it. Dr. Morgan had brought out clearly the influence of the pigment on the durability of the paint when he said, "The durability of a paint depends to a large extent upon the opacity." Arguing from that, one would say that the pigment of greatest opacity would be likely to produce the paint of greatest durability. There was a good deal of theoretical basis for making a suggestion of that kind if one considered that the disintegration of paint was a very complex matter and was largely influenced by the action of actinic light. The greater the opacity of the pigment, the more this actinic light was reflected from the painted surface and prevented from penetrating into the paint film and accelerating its decay.

Dr. Morgan had stressed the importance of drying the pigment. In that connection one generally accepted the idea that the more perfectly dry the pigment was the less trouble one got with proper dispersion. Even this apparently obvious fact appeared, however, to be open to investigation, to judge by a recent experience of which he was reminded. Ultramarine was notorious for the difficulty of obtaining efficient dispersion and preventing separation in ready-mixed paints, and experiment indicated that the difficulty could be largely overcome by retaining a small percentage of moisture in the pigment instead of using it perfectly dry. That seemed utterly against one's theories on the subject, but he had been shown experiments which had entirely convinced him. He would like to ask Dr. Morgan whether he could offer any explanation.

It might be asked, what was the community to gain by carrying out a scheme of organised research. The most efficient paint would prove to be the most economical paint in the end, quite irrespective of its cost, and, therefore, he did suggest that the community at large had a very great deal to gain by the thorough investigation of those problems which had been so ably put before them in the paper.

THE CHAIRMAN, in moving a hearty vote of thanks to the lecturer, said the paper had opened up a vista of enquiry which would allow of a complete programme of research being laid down. It seemed that when one got a really scientific point of view, such as they had had that night, on paint, all the old contentious fights of the industry got down to perfect peace. That was a tribute to the lecturer, and to the calming influence of dispassionate science. It was admirable to be able to realise that science could steer such an easy and smooth way through all the stormy waters which had raged over the questions which had been discussed

that night. If, as a result of scientific enquiry, a paint could be obtained of one year's longer life, he calculated that his Department alone would save annually from £20,000 to £25,000. That showed the importance of science in a practical way. He wanted the audience to bear in mind that as a Government official it was his duty to consider the function of any labour operation as regards the operative as well as regards the adequate and just treatment of the manufacturer. It was, therefore, his privilege to appeal to the industry that if they were going to organise a system of research into the pure technology of the question, research should continue, if possible, on the lines of improving the purely health aspect of the industry and of the operative. The history of Industry had been a consistent, steady improvement of the conditions under which the operative had to pursue his avocation, and in that way health and political quietude lay.

The vote of thanks was then put and carried unanimously.

Dr. Morgan, in reply, said if, as a result of any little labour or trouble which he had expended in putting the paper together, the research scheme which so many had had at heart fructified, it would amply repay him for any pains he had taken in the matter. Mr. Heaton had said that the recent impetus to research was to some extent due to his (Dr. Morgan's) own poor efforts. Personally, he would like to pay his tribute to the old Paint and Varnish Society, to which Mr. Heaton had referred as having worked patiently and steadily without very much appreciation from the powers that be for so many years. They had paved the way, and if he had been able to arouse any enthusiasm during the last month or two it had been largely as a result of their hidden and quite unobtrusive efforts.

ASSOCIATION FOR EDUCATION IN INDUSTRY AND COMMERCE

PRESIDENTIAL ADDRESS.

Delivered by Mr. P. A. Best, Managing Director of Messrs. Shoolbred, London, President of the Association for Education in Industry and Commerce, at the half-yearly meeting of the Association, held at University College, London, on Thursday, 7th January, during the Annual Conference of Educational Associations.

The opinion of the more enlightened leaders in industry, in education, and in political Government on the subject of technical education is in striking contrast to the *laissez-faire* methods of most employers.

Like most great movements in social reformation, this modern movement for the education of the employee by the employer—or with his active co-operation—was set on foot by the magnificent example of two or three public-spirited individuals who have proved conspicuously its success when adopted by their own firms, and have thus fired the trail for others.

For a number of years now, far-sighted schemes, not merely for the technical training but for the general education of their workers, have been consistently carried out by several large industrial concerns, whose names are household words throughout the Empire, and largely through the results achieved by these pioneers a new public opinion is being formed as to the responsibility of employers in regard to the efficiency of those they employ.

The case for industrial training rests on three main grounds :—

(a) The advantage of the business.

(b) That of the employee.

(c) That of the State.

It is difficult to say which of the three benefits the most if the employee is properly trained, or which suffers most if he is left to pick up his job without guidance.

The plight of the untrained employee is only too obvious. If in return for a day's work he receives nothing but a wage, if nothing is done to stimulate his interests, to develop his powers of mind and eye and hand, he soon falls a victim to the blight of arrested development. He gets through his day's work somehow, from a sense of duty, or from fear, as often as not actively disliking it, certainly deriving from it no joy or pride or satisfaction. Picking up his duties—often monotonous duties—by simple imitation from those around him, he becomes acquainted with a few unrelated and apparently objectless actions, and often fails to acquire that skill, precision and speed which are themselves interesting. Being liable to summary dismissal, he then finds that the long hours spent in toil have not benefited him. He has learnt nothing which he can apply elsewhere. Apart from his wages he has nothing to show for those months or years of so-called experience. He has not learnt to think, or to appreciate, or to handle with skill. Even if he holds his position indefinitely there is still very little hope of his distinguishing himself in a way to secure promotion. His leisure hours, instead of being complementary to the day's work, will so compete with it in his mind as to withdraw all his interest from the biggest part of his waking life. Pleasure—the pleasure of relaxation and inaction—becomes his god, the sense of service becoming entirely obliterated. Work and play are to him not the good companions they should be, but antagonistic—the one an unmitigated evil, and the other the only good. I believe I am in no way exaggerating the unfortunate condition of the average untrained worker. He is a blot upon our civilisation—a blot which in no sense is inevitable in a State such as ours.

Now the business which fails to train its employees is courting disaster for itself also. This fact is true of all branches of industry and commerce, that is to say, of all business concerns which finally depend for their success on the excellence of those who labour in them—on quick intelligence and energy of mind, on stout hearts and clever hands, on the powers of leadership and of loyalty, on health and happiness. If there is a single manufacturing firm, or a merchant's office, or a distributing business which needs none of these things, then it alone can afford to neglect the training of its employees. *All* firms want skilled persons of some sort. It is almost true to say that no process in industry is really unskilled. The very lowest forms of manual labour are, from the point of view of speed at least, the result of training and aptitude, and can be greatly improved and the labour greatly lessened by the adoption of properly investigated methods.

Staff training is not a trimming. It is a vital necessity. Industry has as much reason to see that facilities for education are provided for its workers as it has to see that oil is provided for its machines. Any industry which reckons to be paying its way should include the instruction of its employees as an important item of creative expenditure—creative, because money wisely spent on education justifies itself many times over in increased efficiency, health and good morale. Not that an immediate financial return is to be looked for by the employer who spends money on educational schemes. Education brings sure but not quick results. The long view must be taken by all experimenters of this sort, and the employer who is not capable of taking the long view will be disillusioned. Yet the alternative to a

scheme of training is slow work, spoilt work, decreased good-will, lost business—an enormous aggregate of loss if it could possibly be computed. It is surely wise for a business to spend a small percentage of its profits in preventing its life being choked by ignorance, incompetence, and internal discord.

But closely as this question affects the individual employee, seriously as it reacts on the employer, the State is surely not without grave responsibility in the matter. Nothing which tends to lower the civic value and personal welfare of millions of citizens can be considered as nothing to do with the State. It is an encouraging sign of modern progress in thought that two important inquiries are being held at the present time—an official one conducted by a Committee appointed by Lord Eustace Percy, and an unofficial one undertaken by the Committee of which Lord Emmott is the Chairman. The former, presided over by Mr. Malcolm, Chairman of the Board of Education Committee, a distinguished scholar, business man, and Civil Servant, sets out "To enquire into and advise upon the public system of education in England and Wales in relation to the requirements of trade and industry, with particular reference to the adequacy of the arrangements for enabling young persons to enter into and retain suitable employment." The unofficial Committee is seeking "To enquire into the relationship of technical education to other forms of education and to industry." I understand that these two Committees are closely co-operating in their researches. Their findings will be eagerly watched for by members of this Association and by many other interested people. *Of course* the State is concerned! If the majority of employers do not see how they themselves are damaged by the lamentable results of human inefficiency, then surely a day will come when the State will consider itself obliged to safeguard the nation from their short-sighted selfishness. The State has a two-fold responsibility—to the employers themselves and to the public. Why should pauper industries be allowed to operate—those casual-labour industries which can only exist on their present basis by throwing on the ratepayer and taxpayer the burden of keeping alive a large proportion of the labour indispensable to them, during large parts of the year when they are thrown out of work? This is only one way in which the public pay very heavily for the delinquencies of selfish employers.

Granted that both employers and the State are under serious obligations to see that citizens are trained to become efficient employees, and employees to develop into good citizens, and indeed are courting disaster if they do not do so, it is not desirable at this stage to dogmatise as to the exact fashion in which they should co-operate in bringing about the desired results. For we are still in the experimental period. But this I would like to say—that in our opinion a young employee should not have to depend for his technical instruction on evening classes. Time should be set apart by the employer for this during working hours. It is monstrous that a boy should be called upon to do two days' work, one after the other—that after he has finished earning his living during the day he should be expected to spend his evenings in instruction connected with his trade. If he attempts to do so he, of course, unfits himself by weariness for both his work and his study. An opportunity must be given for developing the natural instincts and abilities which exist in, at any rate, a large proportion of all ranks of society.

Evening schools have played, and still play, an admirable part in the education of those adults who wish to continue to develop their minds and increase their culture after leaving school, but employers should surely not regard them as convenient institutions designed by Providence to relieve them of all responsibility for the technical training of their employees.

I hope the day will soon come when the State will insist that firms must make up their minds which of two—or what combination of two—policies they propose to adopt :—

(*a*) To pay for having this training done before they enter industry at all ; or

(*b*) To set aside working hours for it.

For we shall certainly not make headway as an industrial and commercial nation by shirking responsibilities which have become very clear to us.

GENERAL NOTE.

TUNISIAN OLIVE OIL.—It is generally recognised that Tunisian olive oil is one of the best in the world. The fruit is gathered fresh and treated in the most up-to-date manner. As a consequence the analyses made at the Official Laboratory of samples taken from the oils exported have rarely shown more than 1 per cent. of acidity. According to the recent report by H.M. Vice-Consul at Tunis on the trade of the Regency of Tunis, the purity of olive oil in Tunisia is specially guaranteed. On the one hand the sale of oil other than that obtained from crushed olives is strictly prohibited, and on the other hand certificates of origin are only granted after careful analysis.

Olive tree planting increases every year, and there are now 12 million trees, of which 8 millions are fruit-bearing.

The production in 1923 was 220,000 quintals, and in 1924 the same.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 15..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Business Meeting.

East India Association, at Caxton Hall, Westminster, S.W. 3.30 p.m. Mr. K. M. Panikkar, "The Position of Indian States."

Electrical Engineers, Institution of, at the Cleveland Technical Institute, Middlesbrough. 7.15 p.m. Mr. C. W. Blacklock.

At the University, Liverpool. 7 p.m. Mr. P. Dunsheath, "Dielectric Problems in High-Voltage Cables."

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Dr. E. J. Salisbury, "The Geographical Distribution of Plants in relation to Climate."

Société Internationale de Philologie, Sciences et Beaux Arts, 8, Taviton Street, W.C. 3.30 p.m. Mr. J. T. Newbold, "Minerals and Metals in Modern Industrialism."

Transport, Institute of, at Queen's Hotel, Birmingham. 6 p.m. Mr. W. H. Watson, "The Port of London."

University of London, at King's College, Strand, W.C. 5.30 p.m. Baron A. F. Meyendorff, "Tendencies and Types of Agrarian Legislation in Eastern Europe." (Lecture III.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. Dragutin Subotic, "The Battle of Kossovo (1389) in Serbian Traditional Poetry." (Lecture II.)

At University College, Gower Street, W.C. 4.30 p.m. Mr. Henry Higgs, "Some Social Problems in the Light of Economics and Statistics." (Lecture V.)

5.30 p.m. Mr. M. H. Krishna, "Indian Archæology and Anthropology." (Lecture V.)

5.15 p.m. Dr. R. W. Lunt, "The Chemistry of Ionization by Collision." (Lecture III.)

At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture III.)

At King's College, Strand, W.C. 5.30 p.m. Prof. Gaetano Salvemini, "The Political Evolution of Italy in the Nineteenth Century." (Lecture III.)

5.30 p.m. Dr. F. A. P. Aveling, "The Human Will." (Lecture V.)

At University College, Gower Street, W.C. 5.30 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture V.)

4 p.m. Prof. A. V. Hill, "The Physiology of Muscle." (Lecture III.)

TUESDAY, FEBRUARY 16..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.15 p.m. Mr. A. M. Hocart, "The Power of Miracles."

Egypt Exploration Society, at Burlington House, W. 8.30 p.m. Mr. Sidney Smith, "Early Arabian Tribes."

Electrical Engineers, Institution of, at Milton Hall, Deansgate, Manchester. 7.30 p.m. Mr. E. H. Shaughnessy, "Wireless" (Joint Meeting with the Institution of Post Office Electrical Engineers.)

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. Will Day, "Claims to Motion Picture Invention."

Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Zafar Haque Khan, "Studies in Heredity."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Barcroft, "The Egg."

Statistical Society at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Mr. H. C. Scott, "The Rignano Scheme in its administrative aspects."

Transport, Institute of, at Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. C. E. R. Sherrington, "Rail Transport Systems of the U.S.A."

University of London, at the London School of Economics, Aldwych, W.C. 5 p.m. Dr. Hugh Dalton, "Adam Smith and Public Finance."

At University College, Gower Street, W.C. 5.30 p.m. Prof. G. S. Gordon, "The Youth of Milton." (Lecture II.)

At the Institute of Historical Research, Malet Street, W.C. 4 p.m. Prof. Janko Lavrin, "Slovene Literature." (Lecture III.)

At King's College, Strand, W.C. 5.30 p.m. Miss H. D. Oakeley, "Philosophy and History." (Lecture III.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture V.)

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. "Great English Women Novelists." (Lecture II.)

WEDNESDAY, FEBRUARY 17.. British Academy, Burlington House, W. 5 p.m. Commendatore Luigi Villari, "The Development of Political Ideas in Italy in the 19th Century."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. D. S. Matheson, "Subaqueous Tunnelling in Compressed Air, with reference to Barking Power Station Cable Tunnel under the River Thames."

Constructive Birth Control, Society for, at Essex Hall, Strand, W.C. 8 p.m. Mr. R. B. Kerr, "What Malthus said and what Malthusianism is To-day."

Chadwick Public Lectures, at Liverpool University. 5.30 p.m. Sir Frederick Mott, M.D., "Heredity in Relation to Mental Diseases and Mental Deficiency."

Electrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Monsieur Parodi, "The Electrification of the Paris-Orleans Railway."

Ethological Society, at 90, Buckingham Palace Road, S.W. 1. 6 p.m. Dr. Hubert Norman, "Normal and Abnormal Reasoning."

Meteorological Society, 49, Cromwell Road, S.W. 7.30 p.m. Dr. T. H. Somervell, "Temperature at High Altitudes. Meteorological Observations of the Mount Everest Expedition, 1924." Dr. Vaughan Cornish, "Observations of Wind, Wave and Swell on the North Atlantic Ocean." Commander L. G. Garbett, R.N., 'Admiral Sir Francis Beaufort and the Beaufort Scales of Wind and Weather." Dr. J. Bartels, "The Determination of Minute Periodic Variations."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. L. Halphen, "La Conquete de la Méditerranée par les Européens aux XIe et XIIe Siecles."

At University College, Gower Street, W.C. 5.30 p.m. Major Cyril Davenport, "English Embroidered Bindings."

At King's College, Strand, W.C. 5.30 p.m. Mr W. F. Reddaway, "Lord John Russell."

At King's College, Strand, W.C. 8.15 p.m. Mr. Richmond Noble, "Shakespeare's Songs on Shakespeare's Stage."

At University College, Gower Street, W.C. 5.30 p.m. Dr. J. Haantjes, "The Frisian Country, Language and Literature."

5.30 p.m. Mr. J. H. Helweg, "Literary Criticism in Denmark in the XIXth Century." (Lecture II.)

At University College, Gower Street, W.C. 3 p.m. Prof. E. G. Gardner, "The Purgatorio of Dante." (Lecture V.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Earliest Civilisation of the Slavs." (Lecture V.)

THURSDAY, FEBRUARY 18.. Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Child Study Society, at 90, Buckingham Palace Road, S.W. 6 p.m. Rev. Dr. W. C. Poole, "Religion and the Child."

Chemical Society, Burlington House, W. 8 p.m. Mr J. H. Gardiner, "The Ultra-Violet Spectrum of the Rare Earths, Neodymium, Praseodymium, samarium, Europium, Erbium and some others."

Evolution Society, at 8, Taviton Street, W.C. 3.30 p.m. Dr. C. H. Betts, "The Evolution of Thought."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Monsieur Parodi, "The Electrification of the Paris-Orleans Railway." (Joint Meeting with the British Section of the French Society of Civil Engineers.)

Linnean Society, Burlington House, W. 5 p.m.

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Allen S. Walker, "The City Churches."

Mechanical Engineers, Institution of, at Merchant Venturers' Technical College, Bristol. Mr. J. G. Pearce, "Cast-Iron and Modern Engineering Practice." Mr. J. E. Fletcher, "Some Applications of Research to Modern Foundry Practice."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. J. L. Myres, "Who were the Greeks?" (Lecture III.)

Royal Society, Burlington House, W. 4.30 p.m.

Structural Engineers, Institution of, at Great Northern Hotel, Leeds. 6.30 p.m. Prof. J. Husband, "Transverse Bracing of Bridges."

Tropical Medicine and Hygiene, Royal Society of, 11, Chandos Street, Cavendish Square, W. 8.15 p.m. Mr. Patrick A. Buxton "The Depopulation of the New Hebrides and other parts of Melanesia."

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Mr. G. F. Hill, "Italian Medals of the Renaissance."

University of London at University College, Gower Street, W.C. 5.30 p.m. Signor C. Pelizzi, "Vincenzo Gioberti." (in Italian).

At the London School of Economics, Aldwych, W.C. 5.30 p.m. Dr. Walter W. Seton, "The Development of Scotland in the XVth and XVIth Centuries." (Lecture I.)

At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. B. Malinowski, "The Aims of Social Anthropology."

At King's College, Strand, W.C. 5.30 p.m. Vice-Admiral H. W. Richmond, "Sea Warfare."

At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Customary Law in Europe." (Lecture III.)

At the Institute of Historical Research, Malet Street W.C. 5.30 p.m. Prince D. Svyatopolk-Mirsky, "Early Russian Literature." (Lecture VI.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. I. L. Evans, "Economic Development of South Eastern Europe." (Lecture III.)

At King's College, Strand, W.C. 5 p.m. Dr. J. A. Hewitt, "Metabolism of Carbohydrate and Fat." (Lecture V.)

FRIDAY, FEBRUARY 19.. Geological Society, Burlington House, W. 3 p.m. Annual General Meeting.

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. S. Reilly, "Coal Cutting Machinery."

Mechanical Engineers, Institution of, Storey's Gate, St. James's Park, S.W. 6 p.m. Annual General Meeting.

Medical Officers of Health, Society of, at the Municipal Buildings, Glasgow, Dr. A. K. Chalmers, "Heart Disease from the point of view of Public Health Administration." Dr. G. A. Allan, "Heart Disease from the Point of View of the Physician." Dr. E. T. Roberts, "Heart Disease from the point of view of the School Medical Officer." Dr. D. McKail, "Heart Disease from the point of view of the Factory Surgeon." Dr. J. J. Buchan, "Experience at Bradford of the new Notification Clause *re* Venereal Disease."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Address by Mr. Thomas Bell.

Sociéte Internationale le Philologie, Sciences et Beaux Arts, 8, Taviton Street, W.C. 8.15 p.m. Dr. C. H. Betts, "The Evils of Standardisation."

Royal Institution, 21, Albemarle Street, W. 9 p.m. The Hon. J. W. Fortescue, "George III in his Papers."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Ruggles Gates, "Vegetation on the Amazon." (Lecture I.)

At University College, Gower Street, W.C. 5.30 p.m. Miss Eleanor Hull, "Ireland from the Earliest Times." (Lecture V.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Making of Modern Roumania." (Lecture III.)

At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. Graham Wallas, "Social Leadership." (Lecture II.)

SATURDAY, FEBRUARY 20.. L.C.C. Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. Gordon V. Childe, "Ancient Crete and the Myths of the Greeks."

Royal Institution, 21, Albemarle Street, W. 3 p.m Dr. G. Macdonald, "Roman Britain." (Lecture I.)

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FRIDAY, FEBRUARY 19th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 22nd, at 8 p.m. (Cantor Lecture.) G. W. C. KAYE, O.B.E., M.A., D.Sc., Superintendent, Physics Department, National Physical Laboratory, "The Production and Measurement of High Vacua." (Lecture II.)

WEDNESDAY, FEBRUARY 24th, at 8 p.m. (Ordinary Meeting.) MARGARET FISHENDEN, D.Sc., F.Inst.P., Fuel Research Division, Department of Scientific and Industrial Research, "Domestic Heating." PROFESSOR LEONARD ERSKINE HILL, M.B., F.R.S., will preside.

COUNCIL.

A meeting of the Council was held on Monday, February 8th. Present :—Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Sir Frank Baines, C.V.O., C.B.E.; Peter MacIntyre Evans, M.A., LL.D.; Major Sir Humphrey Leggett, D.S.O., R.E.; Sir Philip Magnus, Bt.; Sir George Sutton Bt.; Carmichael Thomas; Professor J. M. Thomson, F.R.S.; J. Augustus Voelcker, M.A., Ph.D.; and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies M.A. (Secretary) and Mr. W. Perry, B.A. (Assistant-Secretary).

Preliminary consideration was given to the question of the award of the Albert Medal for 1926.

Arrangements for the concluding part of the present session were considered.

In response to applications from numerous centres, it was decided to institute a series of examinations in July, in addition to those already held at Easter and Whitsuntide.

Other formal and financial business was transacted.

NINTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 10th, 1926. CHARLES JAMES MARTIN, C.M.G., D.Sc., LL.D., D.C.L., F.R.S., Director, Lister Institute of Preventive Medicine, in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

Allen, Francis J., Seven Kings, Essex.
Arnold, John Falk, B.Sc., Staines, Middlesex.
Cooper, Henry James, Lieut. R.A.S.C., London.
Desai, Maganbhai Vaghjibhai, London.
Hussain, Khateeb Mahmood, M.A., Hyderabad, Deccan, India.
James, Sidney Hamilton, A.M.I.Mech.E., Rangoon, Burma.
Milne-Smith, Arthur James, Sevenoaks, Kent.
Oka, Masakazu, Tokyo, Japan.

The following candidates were duly elected Fellows of the Society :—

Barrow, General Sir Edmund G., G.C.B., G.C.S.I., London.
Benjamin, Charles Menten, London.
Boswell, Professor P. G. H., O.B.E., D.Sc., Liverpool.
Bradley, Warre Squire Leith, London.
Brady, Hugh W., Ranchi, India.
Burt, R. Douglas, Walsall, Staffs.
Butler, H. E. Sir Spencer Harcourt, G.C.I.E., K.C.S.I., D.Litt., LL.D., Governor's Camp, Burma.
Dingman, Charles Francis, Palmer, Mass., U.S.A.
Legge, Sir Thomas Morison, C.B.E., M.D., London.
Mark, Ernest Campbell, B.E., Ewell, Surrey.
Metcalf, Frank H., Holyoke, Mass., U.S.A.
Nicholson, Richard, Longridge, Preston.
Simpson, Thomas James, London.
Weatherell, R. D., London.

A paper on "Modern Views of Vitamins" was read by PROFESSOR J. C DRUMMOND, D.Sc., F.I.C., Professor of Bio-Chemistry, University College, London.

The paper and discussion will be published in the *Journal* dated March 12th.

CANTOR LECTURE.

MONDAY, FEBRUARY 15TH, 1926. G. W. C. KAYE, O.B.E., M.A., D.Sc., Superintendent, Physics Department, National Physical Laboratory, delivered the first of his course of three lectures on "The Production and Measurement of High Vacua."

The lectures will be published in the *Journal* during the Summer recess.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, JANUARY 22ND, 1926.

SIR JOHN O. MILLER, K.C.S.I., LL.D., in the Chair.

THE CHAIRMAN said that he had the pleasant duty that evening of introducing his old friend, Colonel Coldstream, one of those Royal Engineer Officers who had made their career in the Survey of India and had gained distinction therein. Colonel Coldstream was to address the Society on the subject of maps and surveys in India, meaning chiefly topographical maps—such maps as they were all accustomed to deal with, and knew quite well. He wished to bespeak the interest of those

present in this subject, and he would suggest that it was one which had a special claim on the sympathy of the Royal Society of Arts. Mapping was a very old art. He had no doubt that in a rudimentary way it went back to prehistoric times, but the idea of mapping a whole country systematically on a scale that allowed of an adequate representation of natural features was comparatively modern. It was, in fact, of almost exactly the same age as the Royal Society of Arts itself. The Society of Arts dated from 1754. The idea of a systematic mapping of the country came, he was informed, from Scotland a few years earlier. In the Rebellion of 1745 the forces of the Crown were very much hampered, both in their military operations, and he had no doubt afterwards in their ineffective pursuit of Prince Charlie, by the absence of maps, and it was decided that that defect must be remedied. That, he was informed, was the genesis of the Ordnance Survey in this country. This could be linked up with India by something referred to in Boswell's Life of Johnson. Boswell, who had an uncanny *flair* for picking up little scraps of information likely to interest posterity, was told by Mr. Orme that many parts of the East Indies were better mapped than the Highlands of Scotland, a remark that must be taken, not so much as a tribute to India, as a reflection on the Highlands. That was in 1760, so that the desultory mapping of India had begun by that date; and a few years later Lord Clive gave definite recognition to the Survey of India and started it on its career by appointing Major Rennell who was afterwards a very distinguished geographer, to be the head of it. Both in England and India the programmes for mapping the country underwent very many vicissitudes. A scientific basis had to be provided, and then there came periods of war and straitened finance and demands from other departments for special maps. In India at least there used to be an idea that a map which was not required for some specific purpose must necessarily be a luxury. These causes operated against the carrying out of a continuous programme. In England private enterprise supplemented the efforts of the State, but in India there was no Bartholomew. Still, it was in England that the necessity for reform was first recognised. In the nineties of the last century arrangements were overhauled in England, and reforms introduced, with the result that the maps now so well known became available—maps which for accuracy, clearness, and accessibility were, he thought, unsurpassed in any country in the world. (Applause). India's turn came a decade later. Early in the present century it was brought to notice that, notwithstanding the reputation of the Survey of India, and the admirable work it had done in many fields, yet the topographical maps were not such as the Indian Government might expect or as public opinion would very soon come to demand. The matter was taken up *con amore* and very energetically by Lord Curzon, and the experience that had been gained just previously in England was drawn upon. Here he wished to pay a tribute to the memory of Sir John Farquharson, who had been at the head of the Ordnance Survey in England and who went out to India to give the Government there the benefit of his experience and advice. He was a man with very clear and definite ideas of what had to be done and of the best way of accomplishing it, and the advice he gave the Government of India was simply invaluable. It was his last public service, because he died very soon after coming home. Other officers from this country—one at least of whom, he was glad to think, was present that afternoon—came out to assist in the arrangements for the publication of maps. The result was that a definite programme, both of mapping and of publication, was drawn up and put before the Survey of India to carry out. That was over 20 years ago, so the programme was now almost at its majority, and this was a very suitable occasion for a review of the progress of

surveying and mapping in India, both before and after the date of that programme, and such a review, he thought, the Society would have from Colonel Coldstream that afternoon.

The following paper was then read:—

INDIAN MAPS AND SURVEYS.

By Colonel W. M. Coldstream, R.E., C.I.E.

A year ago, an interesting paper on the Survey of India was read to your Society by a friend and former brother officer of mine, Colonel Crosthwait. In treating his subject, Colonel Crosthwait dealt more especially with the scientific framework of all Indian surveys, work which is second to none in the survey departments in its value and importance and in the energy and success with which it has been pursued—work which Colonel Crosthwait was particularly qualified to describe and in which he had distinguished himself by his examination of the theory of isostasy as applied to the results of Indian observations.

To-night, I hope to be able to let you view Indian surveys from the other side, the aspect which is familiar to the official, the merchant and the soldier in India—that of the various descriptions of detailed surveys and maps which are the result and in chief part the object of the minutely accurate observations and computations of the scientific framework.

The cartographical needs of a country new to western civilisation arise somewhat in the following order. First, the pioneers of that civilisation, the explorer and the merchant adventurer, require and have to make some sort of general map shewing the coast line, the great towns and the communications to and between them. Such maps are termed geographical and in their elaborate modern form are familiar to us in our atlas.

With, or after, the pioneers come the soldiers, and the soldiers require something more. They have to make maps showing the ground and its vegetation and water, the physical features and the communications and works of man. That is, in addition to the geographical or, as they term it, the strategical map, they require the topographical map on a much larger scale, the familiar type of which is the Ordnance one-inch or half-inch sheet.

After the soldier comes the administrator and civil official; he does not want so much topography as the soldier. He requires geographical and topographical maps to find his way by and for the administration of his district, but he is greatly concerned with the ownership of land and with boundaries, and it is necessary to make an entirely new sort of map for him on a very large scale. At first, in India, he was content with the survey of the boundaries of the revenue unit, the village, but soon it was necessary to provide him with maps to show the boundaries and areas of each field and there arose a special branch of Indian survey, the cadastral survey.

With the development of the country comes the specialist and the demands on the surveyor and cartographer become bewildering. The forest officer would sometimes like to have a map of his forest to show the position of each teak tree, but at least he must have one that will show him the boundaries and the partitions of his forests, his fire-lines and paths, and to some extent, the nature of the forest growth. For him as for the soldier, it is important that the drainage lines should be accurately mapped, and, as much of the information he requires can only be recorded by himself, he wants a very large scale map with plenty of room on the paper for his notes. Unlike the soldier, but like the executive civil officer, he is not much concerned with the areas outside his particular charge and both the civilian and the forest officer would like to have their particular areas mapped specially and centrally situated, each on one sheet of paper.

The geologist, even more than the forest officer, must himself survey and record his special information, so the scientific department of the geological survey of India was evolved and is gradually extending its surveys over the country. Fortunately, the geologist's requirements in the map on which he makes his surveys are satisfied by the map which satisfies the soldier, and what he asks for is a good topographical sheet to work on, or an enlargement of one.

The railway, irrigation, bridge and hydro-electrical engineers each must make his own large scale plans, but, in the case of large projects, not only must these be based on the topographical or the cadastral sheets and on the level data provided by the professional survey department, but, for the preliminary and general consideration of the project, a topographical map is a necessity.

As civilisation advanced there arose another class of special demand; this time from municipalities and cantonment authorities, for large scale town surveys. The assessment department may require a very special town map to show the limits and areas of each holding, and even the water supply and drainage experts would each like to have a special map on a scale convenient for their personal requirements and, in some cases, showing as little as possible of anybody else's requirements. This is perhaps less unreasonable than it sounds, for there is a very distinct limit to the amount of information that can be shown on one map.

At first, all these demands were satisfied with something comparatively simple and comparatively cheap, but, as the different departments grew and administration became more complex, the old maps proved insufficient and expensive resurveys became necessary in a great many cases. The number and complexity of the different calls for maps in modern times and their conflicting nature led to the remark, attributed to a somewhat perplexed member of the Survey Commission of 1905:—"Why, every official in India wants a special map on one sheet, of exactly the size to fit his own writing table and with his own pet area plumb in the centre of it."

In broad outline, you will have noticed that the requirements amount to the following:—

1. General maps of the country on an atlas scale.

2. A topographical map of the country in thousands of sheets, like our Ordnance sheets.

3. Thousands of sheets shewing cultivated land on a very large scale.

4. Hundreds of special topographical sheets shewing government forests and industrial areas.

5. Many series of very large scale town maps.

Now, from the professional surveyor's point of view, the logical method of dealing with these demands would be to make our original surveys of each area on the largest scale likely to be required—to survey agricultural regions on the 16-inch scale, forest and industrial areas on the 2-inch or 4-inch scale, important towns on some very large scale and the remainder of the country on the 1-inch, or whatever topographical scale is decided on, and to make our smaller scale sheets from reductions of the larger scale maps, extending the surveys gradually over the country, beginning at the most important areas. All these different series of maps should be framed on one great system of sheet lines, designed before the survey of the country is commenced, so that each smaller scale sheet covers a fixed number of larger scale sheets and its mapping commences after the production of the larger scale component sheets.

Possibly, in the dreams of some survey administrator such as the Surveyor General of India, or of Canada, or of the Service Géographique de l'Armée concerned with the mapping of northern Africa, after a long day in office trying to reconcile conflicting demands for surveys with a limited budget, there may occasionally occur a survey Utopia, where professional survey requirements are paramount; but of course nowhere else is there such a Utopia. The actual survey situation in India has been very far from Utopian. Geographical maps, which, professionally, should come last, were the first wanted; some sort of topographical map had to be made in most parts of the country before the large scale needs of the civil official, the forest officer and the scientist arose. The provincial administrations, which had to pay for their revenue surveys, naturally required these to be made district by district, on sheet-lines designed to cover only the areas with which they were concerned. Outside these areas, their maps were like those issued for the "Hunting of the Snark," beautiful expanses of white paper. Even within their areas, the administrations were, naturally enough, not prepared to pay for surveying and recording the information they did not particularly want, but which the traveller, the sportsman and the soldier did particularly want, such as ground features, heights and forests, or other uncultivated or uncultivable land, while on their part, the soldier, the forester and the scientist clamoured for the survey of their requirements in the particular areas which were important to them, irrespective of boundaries of ownership.

We have reviewed in outline the demands for maps in India, and how they arose, and we have glanced at the straight path of professional theory by which they should be met, noting the obstacles which beset it, and we can now turn to the road which has actually been followed, devious and even sometimes at the corners a little retrograde, but becoming straighter and, in our days, approximating to the straight road.

On the screen is an extract from a facsimile of one of the earliest maps of India, if not the earliest, printed in England. It is entitled " A description of East India, conteyning the Empire of the Great Mogoll "and is a later edition of a reprint made in 1632 of a map published in 1619, a copy of which is in the British Museum. The original map was compiled from information obtained by Sir Thomas Roe, ambassador at the court of the great Mogul. It bears a somewhat lengthy Latin title, giving Sir Thomas Roe's name, rank and appointment and the motto " Vera quae visa, quae non veriora ", (the motto is of somewhat doubtful application to the map). In the lower margin are the following inscriptions :—" Reynold Elstrick, sculp., William Baffin delineavit et excudebat," and " Are to be solde in Paul's church-yarde by Thomas Sterne, globe-maker."

It has been stated, I do not know on what authority, that the William Baffin who drew the map was the famous explorer of the North-West passage, who may have been an officer on board the ship by which Sir Thomas Roe returned from the East. If this was so, we can imagine the old diplomatist and the keen naval officer searching the former's notes and exploring his recollections, in order to draft on paper, by means of rough distances and directions from Delhi, or from the coast, the geographical fruits of many a conversation with Indian travellers and merchants at court, over the campfire, or on the serai chabutra.

You will have noticed many familiar names on this extract. It is true that some of them are very much out of their positions as we know them, but I doubt if many retiring Indian officials could prepare a much better map merely from their experiences and reminiscences, supposing that they had never seen a good map of India.

The basis of geographical knowledge and the most widely called for of survey demands is the topographical map.

The rudimentary form of this class of map, prepared by Englishmen in India, is to be found in the sketches and reconnaissances made by officers for and during the course of military operations. There are many of these old sketches of the 18th and early 19th centuries in the survey office at Calcutta; as a rule, they are beautifully drawn and coloured and appear to represent the ground well, but, only in rare cases has the work been tied together by any sort of geodetic control or been sufficiently extended to allow of the preparation from it of a topographical map which would be of general use. The first systematic

development in India of military reconnaissances to provide a regular series of topographical sheets was in the case of Major Rennell's surveys. Rennell, who has been called the father of Indian geography, was born in Devon in 1742, and, after some years service in the navy, was employed in what we should now term the Military Works Department at Fort William. From that time until his retirement in 1776, he was occupied with the topographical reconnaissance of the Ganges-Brahmaputra delta. In 1767, he was appointed "Surveyor of the East India Company's dominions in Bengal", and it is from that appointment that the Survey of India dates its existence. The work was arduous and not without its risks, for we read of Rennell being severely wounded in a skirmish with fanatic rebels in Northern Bengal, and we know that he surveyed enormous tracts of country, assisted by only a small staff of officers, during the years of his service.

Here is an enlarged extract from a map in Rennell's atlas, entitled "Bengal Atlas containing maps of the theatre of War and Commerce on that side of Hindustan." I should like to be able to show you an extract from a modern map of the same area, for it is interesting to see how greatly the waterways of Bengal have changed during the last 120 years. So much is this the case that I found it difficult to locate this extract. A few of the village sites and names have remained and one can trace the beds of some of the rivers as they existed when Rennell surveyed them, but there is hardly a water-course that now runs, even approximately, in its old channel.

Early in the 19th century, a somewhat similar series of reconnaissance surveys was carried out by and under Colonel Colin Mackenzie, chiefly in the South of India, and some of them were afterwards utilised in the preparation of the sheets of the old $\frac{1}{4}$-inch map of India, known as the Atlas of India, to which I shall refer later on.

These reconnaissance surveys were succeeded by one-inch surveys of scattered areas, the maps of which formed separate series with sheet lines which did not conform to a graticule of meridians and parallels, but were drawn to include the limits of administration. Typical examples are the Hyderabad Circar maps, which were surveyed and published between 1840 and 1850. These are among the earliest one-inch Indian maps prepared from systematic topographical surveys extending over large areas.

The extract on the screen is from the map of Pyton Circar, surveyed in 1842-43. The mapping stops short at the Circar boundary, leaving the area outside the Circar blank. The art of depicting ground features was not far advanced in 1843. On most of the Circar maps short vertical hachures were used, as on this map, to show slopes, but some of the maps were shaded. The reticule of fine dotted lines represented cultivation. The maps were engraved and printed from stone.

The modern method of topographical survey which has been adopted all over the world is plane-tabling. It is perhaps pertinent to add that in future the

method will often be supplemented by and, possibly, even replaced by photographic survey from the air. The method, which is a rapid one and in the hands of a skilled topographer an extremely accurate one, had its origin, as a regular survey method, in the Indian survey and one of the earliest, if not the earliest, exponent of the art was Captain D. G. Robinson, of the Bengal Engineers, who surveyed large tracts in the North of India between 1850 and 1860.

The map on the screen is from one of these early plane-table surveys of the 'sixties. Officers had more time in the old days and many of them were topographical artists and drew the finished maps with their own hands. The maps were copied on to stone by a specialist drawing establishment and the hills were often shaded in mezzotint. By 1867 it was found difficult to cope with the publication of the increasing number of maps by so slow a process and photolithography was introduced, to be followed a few years later by photozincography. The manuscript maps had now to be drawn specially for photography, generally on a larger scale than that of publication. Hills and slopes had to be represented by line work alone and the fair drawings were prepared by the officers and men of the party who had carried out the survey, and these necessarily varied in skill, so that some of the new maps were less clear and artistic than the old.

Hills were shown on many of our Indian maps from the 'sixties to the 'nineties by short horizontal hachures. The method is susceptible of great fidelity to fact combined with artistic effect, but it cannot give accurate information as to height. The names were originally hand-written. Gradually the hachures became more continuous and eventually approximated to form-lines, that is, to sketched contouring, and hand-lettering gave place to typing. The change from the short hachures drawn with artistic expression to the expressionless form-line was not made without opposition on the part of the older school of Indian surveyors and I believe credit for their conviction is due to Major Hobday, who in the 'eighties introduced the habitual use of the clinometer in his party and practised and advocated the new method.

The next advance in the topographical maps was the printing of the form-lines in brown. This added to the clearness of the map. The smooth form-line in black did not differ from the lines representing certain types of roads, enclosures and ditches.

We have seen something of what the older topographical maps were like, and, before discussing the reorganisation which introduced the modern methods, it is necessary to glance at the progress made in providing a complete topographical series of sheets for India, and to mention the cadastral surveys.

The first step towards the provision of a complete series of sheets for India was taken in 1824 when a projection for a map of India on the scale of $\frac{1}{4}$-inch to 1 mile was planned to cover the country as it then was. The map is called the Atlas of India and the first sheet was engraved and published in 1827.

The hills are shown by finely cut vertical hachuring on the system of the caterpillar ranges of our old school atlases. The method was a good one for small scale mapping, and even on the topographical scales could be made to represent ground faithfully; the lines being drawn to show the courses water would take in flowing down the slopes, but it is not now employed for topographical maps and, even on small scale maps, it has generally been superseded by the more scientific method of layered contouring.

By 1905, when all new work on the Atlas sheet was stopped, practically the whole of India, with the exception of Burma, had been mapped in Atlas sheets.

The magnitude of the task delayed any similar attempt to produce a uniform map of India on a larger scale. For many years the publication of the results of topographical surveys, other than as Atlas sheets, followed no systematic plan. Detached surveys were executed and their maps, generally on the one-inch scale, formed separate series (as we have seen in the case of the Hyderabad Circar maps). An important advance was made towards the middle of the nineteenth century when the separate series for each survey was discontinued. India was now divided into " Standard " sheet areas of 30 minutes of longitude by 15 minutes of latitude, and these standard sheets were published as provincial series with separate serial numbering for each province.

The provincial series were never quite completed. There were large gaps in Madras and elsewhere, and they are now being rapidly superseded by the modern surveys begun in 1905.

The topographical maps we have been discussing were no doubt very useful to the civil official, but they could give him no information regarding the ownership of land, information which is essential for revenue purposes.

The basis of land registration under Indian conditions is necessarily some sort of map and, even before the advent of the English, Indian revenue officials used to make rough diagrams of their village lands. In the early years of the nineteenth century the revenue maps were still little more than rough eye-sketches, prepared by the village patwari, or accountant, as an index to the land records of the village and showing, as well as he could, the relative positions of the fields.*

Regular fiscal surveys appear to have been begun about 1837, and, until about 1870, they were made on the scale of 4 inches to one mile and known as Revenue Surveys. Although in some early cases the Revenue survey maps showed merely the boundaries of the village lands and, very roughly, the extent of cultivation, they were, in other cases, very fair large scale topographical maps, showing, in addition to these items, the water courses and surfaces, the woods, prominent trees, roads and village sites, but giving very little if any, information regarding the features of the ground. Revenue maps were not usually printed. The original drawing was generally coloured and from it traces were made for the different authorities concerned. For many years, a large number of the oldest one-inch standard sheets were prepared

from reductions of these maps. In flat country, the results were fairly satisfactory, although inferior to sheets prepared from topographical surveys. The quaint diagonally lined strips you see on this extract represent the bunds or embankments which are so marked a feature in low-lying districts like Hoogly.

As land registration became more detailed and accurate, the 4-inch scale proved inadequate, for the boundaries and areas of each field had to be ascertained and recorded with accuracy. This necessitates a very large scale and one of 16 inches to one mile, or 10 chains to one inch, was adopted and has been used throughout India, except where, as in parts of Bengal and the United Provinces, the fields are so small (some of them no larger than an ordinary dining room) that a specially large scale had to be resorted to. Cadastral maps, as they are called, from Capitastrum, a poll tax list, are essential for modern land registration in India, and from 1870 until the end of the century, by which time most of the provincial administrations had taken over the work of maintaining and revising their own cadastral maps, a large proportion of the professional survey department was employed on cadastral surveys. The method by which these surveys were made has differed a good deal in different provinces, but those recognised as the most efficient were introduced in what was then the North-West Provinces about 1870 and were adopted later in Bengal, Burma and elsewhere. Under those methods the village boundaries were surveyed professionally by theodolite and chain traverses which were also run at intervals across the larger villages. The rest was done by the village patwaris working under professional control. To carry out the cadastral survey of a rural district in great part by the agency of the petty village officials would appear to be a somewhat risky and ambitious proceeding, but there were two reasons which made it not only feasible but reasonable in India; the simplicity of the portion of the work to be done in this way, and the existence of a hereditary class of village official, accustomed to, and, to some extent, skilled in land measurement and recording. While topographical surveying is an art which requires long apprenticeship and special aptitude, including a delicate touch with the pencil, a good eye for country, much physical activity and power of endurance, and last, but decidedly not least, a high standard of professional faithfulness, the making of a large scale plan by chain measurement, once the accurate framework has been provided, is a mechanical process, laborious, but not requiring much physical or mental activity and with the very great convenience, from a professional point of view, that the work in a great measure checks itself and its accuracy is very easily proved.

In the United Provinces the patwari's appointment is hereditary. In the latter half of the nineteenth century, when the cadastral surveys were made, he was not seldom the only man in the village, except the banya, who could read and write and work simple sums in arithmetic. His education extended

very little beyond this, but many patwaris, perhaps the majority, were faithful, hardworking and, according to their lights, reasonably efficient and honest officials. The appointment, although so onerous, and so poorly paid, was an important one and often gave the incumbent great influence in his village. It was sometimes lucrative and in these cases the sources of income outside the regular pay, were not always unholy, for the patwari was generally kept, more or less, in the narrow path of rectitude by the watchful suspicion of every man in the village and, I believe, also in very many cases by an innate sense of official responsibility and honesty.

When it was decided to prepare cadastral maps of a district, in view of a re-settlement of the land tax, the first step in the survey, after the professional traverse operations had been carried out, was to collect the patwaris at convenient centres and teach them how to survey their villages on the plotted sheets prepared for them. On the day appointed, a heterogeneous crowd would turn up. Perhaps 60 per cent. would be reasonably intelligent and active men, who would learn the use of the simple instruments in a few days and, at the end of a few weeks, would be ready to return home with their plotted sheets to begin the survey of their village lands. But, there would be a fair proportion of unfit, or very unintelligent men, including always a sprinkling of old greybeards, whose hands could not be trained to use a pencil and whose brains, suffused with amazement at the modern eccentricities of the sircar, could not grasp the new methods, although the old hands would patiently fumble with the pencil and the brain, with unquestioning loyalty, would do its best. Such men were generally accompanied by an heir, perhaps a grandson, 12 years old, who, with Eastern precocity, would pick up what was required of him at once. It was only in rare cases that there was not forthcoming a patwari or his heir or a substitute appointed by him capable of learning the work. In these rare cases an amin or professional cadastral surveyor had to be appointed.

This is an extract from the cadastral plan of a village in the Mainpuri district surveyed by patwari survey in 1903. You will notice that every field and every portion of the village land which is not a field is serially numbered. The numbers are those of the entries in the field-book under which information is recorded. Those of you who have not been in India may naturally think the ground represented is very enclosed country. On the contrary, it is quite unfenced, except along the high road, for the limits of the fields are merely little ridges of earth, perhaps only 6 inches high and a foot wide, in some places so faintly marked as to be difficult to find. These ridges, or mendhs as they are called, possess, however, the quality of permanence in a marvellous degree. Unless a new railway or road or canal has been made through this village, it would be fairly safe to wager that 90 per cent. of the fields have remained as they were when this survey was made. Occasionally a piece of waste land may have been made into a field and the little

water-course may have crumbled its banks here and there. On several occasions, I examined the maps of a number of villages, which had been surveyed 30 years previously, in order to ascertain whether a revision of maps was necessary and, except where the normal condition of cultivation was of a fluctuating nature, as in parts of Bundelkhand, I found as a rule, that the maps had remained unchanged, and I have been told that it is possible to recognise fields from the old eye sketches made by patwaris before the British occupation. We are accustomed to the unchanging nature of our English fields whose names and boundaries have in many cases lasted since Saxon times, but our fields are enclosed and large and have not lacked protection by the sword and the pen. It is this permanence possessed by the little mendh that alone justifies the heavy cost of their survey and I think also that it reflects credit on the peaceful Indian villager, who must often have stolen out to repair his mendhs after watching " the legions thunder past."

From the highly developed cadastral surveys, such as this Mainpuri survey, it is possible to prepare a good topographical map, provided that a skilled surveyor goes over the ground and supplements the information, so that the existence of the cadastral maps has cheapened and expedited the modern topographical work to a considerable extent in parts of India. Before 1905, a large number of the standard sheets were made from the cadastral maps merely by selection of details without any revision in the field.

Returning to the geographical small scale mapping, of which we have seen an extract from the earliest specimen, we find that a general map of India was produced by D'Anville, in 1754, followed by a more accurate map prepared by Rennell, in 1778, during his retirement. A succession of general maps on the scale of 32 miles to 8 inch and smaller scales have appeared since Rennell's map, leading to the engraved coloured maps of the present day.

At the close of the nineteenth century, the labours of Indian surveyors and draftsmen had attained the following results :—

A practically complete $\frac{1}{4}$-inch map of India, in engraved atlas sheets as regards India proper, and in rather roughly executed heliozincographed sheets as regards Burma. Partially complete provincial series of 1-inch " standard sheets," some of the lacunae in which were without maps at all, some mapped only in the old atlas sheets on the $\frac{1}{4}$-inch scale and some were covered by 2 inch or $\frac{1}{2}$-inch series.

There were 16-inch cadastral sheets for cultivated areas in most of the agricultural districts.

There were large scale town maps of many of the larger towns and the more important cantonments.

The older government forests had been mapped on the 4-inch scale.

Beyond the frontier, large areas in Afghanistan and Persia and a fringe along the Northern and Eastern frontiers had been mapped from reconnaissance

surveys and sketches made during military expeditions and boundary or political missions.

A series of sheets on the 1/million scale were in hand.

There was thus an enormous mass of mapping in existence, Much of it was very old and out-of-date and it varied greatly in scale and in quality. Some of it, even well within the administrative border, was merely reconnaissance work, and sheets were drawn in different styles, with different conventional signs, so that where an old sheet touched a later one the work would not join up.

The Indian surveys had, during the century, built up an increasing reputation for skill and thoroughness in their field-work and were, perhaps, the leading school of topography in the world, but the maps in which their results were published had fallen much behind the maps of certain other countries and in some ways had rather deteriorated than improved.

There were several causes for this tendency of Indian cartography to stagnate towards the close of the nineteenth century. The maps were no longer drawn by officers and copied by skilled lithographic draftsmen ; the Indian surveyor was not always an artist ; possibly too, the fault was partly due to the fact that the road to distinction and promotion lay in the field and not in the office. These were, no doubt, contributory causes, but more important was the question of funds. By the end of the century very great advances had been made in the processes of map reproduction outside engraving. Engraving yields the finest maps but it is a very slow process and a very expensive one. It had been adopted for the Atlas of India, several hundred sheets, but it was out of the question to employ it for some 7,000 one-inch sheets, many of which covered country that was only entered at intervals of years by any one who could use a map at all. On the other hand, photographic methods had improved, so that the difference in quality between photographed maps and engraved maps had diminished greatly. The necessity for keeping up-to-date in methods of map reproduction was not one likely to impress itself very strongly on governments concerned with insoluble problems of Indian finance. It gradually became clear, however, that something had to be done if the results of costly surveys were to be done justice.

The calls for special surveys had also for many years affected what was, after all, the basic survey requirement of India, the preparation of the topographical map. This main purpose was becoming more and more difficult to pursue and the protests of the surveyor had insufficient power to resist what were sometimes felt to be unessential demands which frittered away their resources. Lord Curzon, in his unceasing struggle for efficiency, did not overlook this state of affairs, and eventually a commission, with representatives from the Ordnance Survey, the Survey of India, the General Staff and the Indian Civil Service, was appointed under Sir John Miller, as President, to go into the question of surveys in 1905. The general proposals of the Commission were accepted and gave the Survey of India what was practically a new charter.

The principles adopted and the measures put in hand may be briefly summarised here.

The scales of publication were in future to be 1/1 million, in sheets of 4 degrees by 4 degrees; ¼-inch to one mile, in sheets of 1 degree by 1 degree, and 1 inch to 1 mile, in sheets of 15 minutes by 15 minutes. In very sparsely populated and barren regions, e.g., those at very high altitudes in the Himalaya, the ½-inch, or even the ¼-inch scale, was to be substituted for the 1-inch. All these maps were to be reproduced in full colouring by modern photographic methods; the topographical maps were to be contoured and the main efforts of the Survey of India were, in future, to be concentrated on the preparation and completion of a new topographical survey of the country.

The whole strength of the Survey of India, except the officers and men required for geodetic operations, was now re-organised for the survey and publication of the topographical maps. Special surveys, including forest surveys, were reduced as far as possible and the cadastral work was still further divorced from the department, officers being lent to the local governments to control their cadastral surveys.

In order to help India to undertake the new and improved methods of map printing that were necessary, Major Hedley, an experienced officer who had served in the Ordnance Survey, came out to Calcutta, where he successfully revised the organisation of the map reproduction offices.

This is one of the first sheets printed under the new system. I should like to have had a slide of one of the more recent sheets of hilly country to show you, because, since this sheet was printed, the one-inch sheet has been still further improved. In 1908, sheets like this were rightly considered a great advance in Indian cartography.

As printed, this map shows water in blue, houses and roads red, wooded areas green and contours brown. Later, two more colours were added, yellow for cultivation and grey for hill-shading. Hill-shading is an unscientific art. You cannot work so accurately to a scale which represents a given gradient by a given density of shade that you can measure the gradient off the map by the shade. But there is no doubt that hill-shading does enable the map reader to grasp the general lie of the country rapidly. From the contouring alone, it requires a much closer examination of the map to understand the ground. Cultivation, if coloured, is another great aid to the visualisation of the country at a glance. Another minor improvement is the distinction of different sorts of trees, conifers, palms, deciduous, etc., and this, too, enables the map reader to recognize the sort of country the map represents.

The methods by which the map is reproduced are interesting. The surveyor's field sheet is enlarged by one-half photographically. Generally speaking, all maps to be reproduced by photography are drawn on a larger scale than that of publication. This is in order that the sharpness of definition and accuracy obtained by photographic reduction may be gained. Two prints of the map, in

blue, on drawing paper, are given to the draftsman. On one of these the contours are drawn in black; on the other, the whole of the rest of the map. Blue prints are used because blue does not photograph, so that the roughness of the original field drawing disappears when the drawings are photographed, leaving only the carefully drawn work on the top of it. The two drawings, one of contours only, the other of the rest of the map, are then photographed on the one-inch scale. The contour negative is printed on to zinc and is ready for the printing machine. Several negatives of the outline drawing are made. From one of these all of the map that is not to appear in black is obliterated, and a zinc plate showing only the black lines and letters is prepared.

The blue and the red plates are prepared in a similar manner and the green plate by transferring a stipple or grained surface on to the wooded areas of another plate. Consecutive impressions from the five plates are then superimposed on the paper in the printing machine, resulting in the fully-coloured map. More recent sheets receive seven impressions, there being the yellow cultivation and the hill-shading to print in addition.

Four one-inch sheets cover exactly the area of one half-inch sheet, and the half-inch sheet is prepared in a similar way, using the one-inch sheets instead of surveyor's field sheets.

From four contiguous half-inch sheets, the quarter-inch sheet is made. The ¼-inch sheet covers one degree of latitude by one degree of longitude and is generally known as the degree sheet.

Sixteen degree sheets make one sheet on the scale of 1/million, or approximately 16 miles to one inch. Now the map on this scale of approximately 16 miles to one inch is a very important map in India. For not only is it the general geographical map of the country and the adjacent countries, so far as these are mapped by the Survey of India, but it is the index unit of the whole of the mapping. Each of the 256 one-inch sheets, of the 64 half-inch sheets and of the 16 degree sheets included in a 1/M. sheet is designated by the number of the 1/M sheet and by a system of letters and figures which give the position of each inside the 1/M sheet.

The Indian 1/M map is engraved and the hills and heights are shown on it by the method of different layers of colour, on the system familiar to us all in the ordnance ½-inch sheets. The great map-making firm of Bartholomew in Edinburgh, the Ordnance Survey and the Survey of India, have all borne a part in the development of this system of hypsometrical layering.

Towards the close of the 19th century, there had arisen among geographers a movement in favour of the preparation of an international map of the whole world on a uniform scale and design. The first definite proposal was mooted at the Geographical Congress at Berne in 1891 and, in 1909, an International Committee met in London, under the auspices of the British Government, and decided on a 1/million map, for which the finished detailed design was published in 1913.

Some time before the international 1/M map was decided on, India had started making maps on this scale, so that, as India was one of the countries which agreed to map her areas in the international form of map, she has to prepare two sets of sheets on this scale.

La Carte Internationale differs from the Indian map in the larger size of its sheets, in using the metre instead of the foot as the unit of height measurement and there are slight differences in the scale of colour layering and in the lettering and symbols. The two maps are, however, not very unlike each other, although they are the results of independent design.

Early in this paper I mentioned that, in future, photographic survey from the air would probably play an important part in topographical surveys. Some years ago, just after the war, the Survey of India tried the method experimentally, with the assistance of the Royal Air Force. The results were not very satisfactory, but they were not conclusive. They did show, however, that, in ordinary circumstances, ground surveys cannot be replaced by surveys from the air and that, ordinarily speaking, supplementary survey on the ground is necessary to complete survey carried out from aeroplanes. About 4 years ago, however, a case cropped up where photographic survey from the air did seem clearly called for. The circumstances were these :—

The Irrawaddy delta is covered by valuable forest and intersected by innumerable water-courses at intervals of a few hundred yards, of widths varying from a few feet to over a mile. The region is very inaccessible except by launches and small boats, and it is very unhealthy; there is a scarcity of fresh water and, in parts, the jungle is practically impenetrable.

The forest department found that enormous thefts of timber were taking place, by which the State was losing heavily and the department complained that it could not develop or exercise any system of control over the forests in the absence of good maps.

The local survey department had done a season's work in the delta and had secured a small area of survey in the half-settled fringe of the region. They had found the work exceedingly expensive and they had lost a certain number of lives. In the ordinary course of its programme the Survey of India would have to survey the region and it was decided to undertake it at once. It was quite evident that, if the survey were carried out by ordinary methods, the cost would be heavy and there would almost certainly be some loss of life. Except in regard to the timber on it, the land was not valuable and it was uninhabited, except along the fringe. For forest purposes extreme accuracy was not essential and, except for the intricate network of water courses and the occasional clearings in the jungle, there was very little to show on a map. The conditions were therefore ideal for survey from the air, for waterways and jungle clearings show up beautifully on aeroplane photographs and require little or no supplementary survey on the ground. It was evident that, if ever an aeroplane photo-survey were to be a success, it should be a success under these conditions.

Eventually a very capable flying officer was found to organise the flying part of the work and co-operation between him and the Survey of India has resulted in a satisfactory map.

The Survey of India is about halfway through its present programme of surveying India and publishing the topographical maps in modern form.

It requires some 6,000 one-inch sheets to cover India, but about 2,000 of these are in such inaccessible sparsely inhabited regions that one-inch sheets will probably not be made and the half-inch map will suffice for them. Over 2,000 one-inch sheets have been published and some 2,000 remain to be done.

Out of some 1,650 half-inch sheets, over 600 have been published and out of 450 degree sheets, 150 have been published.

Thirteen or fourteen of the sheets of the International map have been published.

A considerably larger proportion than half of the programme would have been finished but for the war, when survey work came nearly to a standstill. Practically all our younger engineer officers went to France and a large proportion of them became casualties. They could not be at once replaced by experienced men. Sophocles has said that "war does not take the stupid man, it takes the best," and I think that some of us, whom the war did not take, feel that there is some truth in this.

Col. Crosthwait, last year, touched on the extensive surveys carried out by Indian surveyors during the war in Mesopotamia, Persia, Gallipoli and German East Africa and I wish I had time to tell you something of the survey work in the little Indian border wars.

I have been able to say nothing of the Indian surveyors to whom we owe our Indian maps, of their patient endurance and of their zeal for the work under arduous conditions in peace and in war.

The Indian surveyor's life has its risks. In the course of two seasons' work, the casualties among the Indian surveyors and khalasies, working in the east of India alone, included the following: one killed by a jungle trap for wild animals, one murdered, one seized by a crocodile, one killed by lightning in the mountains and 5 khalasies killed by a tiger. Another man was mauled by a bear, but escaped.

I have only sketched my subject. Several of the points I have touched on would require each a paper to themselves to develop. Apart from the technical processes of survey and map-making, interesting to us sappers, but rather dull to the rest of us, there is much that one would have liked to say about the more human side of Indian surveys.

There is the vision of the ideal topographical map, the map that lets you visualise the country, which we map-makers find so impossible of attainment that we have to compromise with the second best and often disagree strongly about that. Very tempting to dwell on would be the romance and beauty of work in the lonely mountains and the remote jungles.

There are men here whom I hope may speak, but who would not speak if we were likely to be late, experts in survey and map-making and other members of a great sister service, who are experts in the revenue side of survey work and who, in one Indian province at any rate, have evolved an efficient cadastral system of their own.

DISCUSSION.

THE CHAIRMAN said that he was sure the Society was under a very great obligation to Colonel Coldstream for the very interesting and complete account he had given of the programme of mapping in India from the earliest times up to the present day. All those present would feel that they knew very much better than before how maps were made and what it all meant. He had also to thank Colonel Coldstream for some kindly reference to himself and to the difficulties he was supposed to have encountered in steering a report through a Survey Committee many years ago. He was afraid he must admit that that report contained a record number of dissents, but the Government at all events had the advantage of two points of view before them. It was an interesting fact that the only other surviving member of the Committee was present that evening. There were a number of experts present whom everyone would like to hear and who could speak on the progress which had been made towards supplying India with the ordinary maps such as were required by the soldier and the engineer and that very exacting but inevitable individual, the motorist, whose demands were ever increasing.

COL. C. H. D. RYDER, C.B., C.I.E., D.S.O., thought that the motto of the Society must be "Modesty." No one who had listened to the Paper would have realised that for years and years Colonel Coldstream himself was the mainstay of the Survey in the preparation of maps. He had not mentioned the difficulties in Calcutta in the matter of climate. England was thought to have a fairly changeable climate but it had a certain advantage over India in that for three quarters of the year Calcutta had an absolutely poisonous climate from a map-maker's point of view. Either it was too hot and dry or else too hot and wet, and the amount of labour entailed in simply bringing the paper on which maps were printed back to its proper size was quite alarming. Colonel Coldstream carried this and many other duties to a most successful conclusion for very many years, and the speaker did not think there was anyone better qualified to describe maps and how they were produced than Colonel Coldstream. Sir John Miller, as President of the Survey Committee in 1905, was a source of great life and vivification to the Survey. That Survey Committee's report, although it had many minutes of dissent, had a very great and beneficent effect on the whole Department. He (the speaker) was in the Department at the time, and remembered well how cheerful they all felt when they saw the report and found that it was more or less approved by the Government; they felt that they would soon get going. Sir John had a difficult job working that Committee through various differences of opinion, and the fact that only one member survived at present was a testimony to his skill! He wished that it had been possible to show the maps in colours; they were really very beautiful and artistic productions. But map production was easy compared with persuading people that maps were a necessary adjunct of civilised government. He had often been startled by high officials, holding almost the highest appointments in the Government of India, who said that they had never used a map, could not see the good of it, and disapproved of every proposal to spend money on map

production. This was true not only of India but of other colonies and dependencies. He would like to get all governors and high officials into a room and starve them into submission until they agreed that maps should be made of their territories. It was only by maps that a country could be developed. A great amount of money was wasted because, after a refusal to have ordinary maps of a country made, there came a moment of emergency when there was a sudden demand for maps of all descriptions and sizes and shapes, with which no Department could possibly cope. If only governors or rulers of provinces or states would realise that before they could develop a country, conserve forests, or build railways or canals, they must have really good maps, and that any money they spent for this purpose before the necessity for maps arose would be repaid tenfold, a long step forward would have been made.

Sir Walter Coote Hedley, K.C.B., said that it was about twenty years ago that he went to Calcutta, to his great surprise, to assist in re-organizing the Publication Department of the Survey of India. He went with great trepidation because he had always looked upon the Survey of India as the *ne plus ultra* of survey ability in all directions. They had especially a great reputation for scientific work and for efficiency in every department of the field, and at one time their maps were up-to-date, and were reproduced, according to the standard of those times, as well as they were surveyed in the field. So he went with much trepidation, but when he got to Calcutta he did, fortunately, find that with the help of an assistant whom he took out with him in a technical capacity, he was able to bring to bear information about the reproduction of maps which the Survey of India did not possess. This was not really anything to his credit, it was merely due to the fact that he had happened to be employed at the headquarters of the Ordnance Survey at Southampton, and for some years he had been in touch with what they considered the most efficient methods of map production, whereas India was cut off by a great number of miles from all the methods then in use in England, and, to tell the truth, did not seem to have troubled herself very much about them. He was, however very fortunate when he got to Calcutta. There were two men there, one, Mr. Taylor, a photographer, than whom no better photographer ever lived, and the other, Mr. Vandyke, a lithographer, to whom the same compliment must be paid. The lithographic process called the Vandyke process had been invented by him and had been the mainstay of the Ordnance Survey as well as of the Survey of India for the reproduction of maps wanted in black only. The speaker found all the officers ready to give him a free hand, so he had nothing to do except introduce the methods which had been in force at Southampton into the office at Calcutta. A certain amount of re-organization was necessary. After he had been there about a year he was fortunate in getting Captain Coldstream (as he was then) to come to his assistance and to be ready to carry on when he had gone away. By the time he (the speaker) went away Colonel Coldstream had absorbed all the information he was in a position to give him. It was very gratifying to him to feel after this interval of eighteen or twenty years that the maps were now reproduced without any change whatever so far as he knew by the methods which were introduced at that time. He had always looked back with much satisfaction to that time, and he had the feeling that, whatever else he might have done, those two years at all events were not wasted.

Col. H. St. J. L. Winterbotham, C.M.G., D.S.O., wished to say a few words to express the admiration of British surveyors for the Survey of India, not only for its published maps, but for its actual survey. The importance ascribed to

the plane table was due to officers of the Survey of India. Lord Kitchener, who was a surveyor in his time on the survey of Cyprus, classified the plane table as a very inadequate and inaccurate instrument, and preferred himself the compass. The lecturer had spoken about the different people who wanted maps, but he had left out a certain number. For example, those who dealt in natural resources had to do with large-scale maps; then there was the archæologist and many others. The author had divided the claims of the civilian from those of the soldier; in fact, he classified the soldier with the sportsman, but put him in sharp opposition to the scientist and the revenue official. The speaker did not think that this was the true distinction. The distinction was between the use that was going to be made of the maps, whether intensive or otherwise. The soldier was an engineer, a forestry officer, and a user of ground in every way. The town major was the cadastral expert, so was the billeting officer. Some newspaper correspondents had even associated the general staff with the archæologist. The distinction lay between the intensive and the less intensive uses of the ground. With regard to what had been said about the Committee, it seemed to the War Office at the time that the area of India was far too large to classify under a general head. From the soldier's point of view one wanted a big map where the place was important, and a small scale map where it was not important, and the idea was that no general rule could be made for so wide and diverse an area as India. He also wished to comment on the presidential address in Section "E" of the British Association meeting at Southampton last August. That address had pointed out the unfortunate apathy of the Anglo-Saxon abroad to this question of mapping. It was astonishing to contrast that apathy with the great schemes which India had carried out in the survey of that enormous area and the resolution with which this had been done. With regard to what had been said about colonies where map-making was not regarded with favour, one could only hope that the example of India would spread. The author had referred to the question of photographic survey. In our own country there was no scenery like the Alps or the Rockies; it was only those countries with natural advantages for photogrammetry—countries like Switzerland and Southern Germany—which had been able previously to make the full study of the facts, but, of course, the advent of air photography had brought photogrammetry personally home to them all. The colonies stood to reap considerable advantages from the use of this new and valuable method. Since the war, although little had been said in England, this did not mean that li tle had been done. The ground had been thoroughly explored. There existed in England companies which were fully as able to compete in photographic surveys over large areas as in any other country. Finally, he said that on a question of terminology it was not possible to distinguish between strategical and tactical, because they did not know which they should do on this scale or that, so they referred to maps simply as "standard", "large" and "small" scale.

THE CHAIRMAN said that he had intended, if he had spoken after the lecturer, to say something about the scale of survey, and the previous speaker's remarks gave him an opportunity. It was a point on which he was very much interested. When the Survey Committee was sitting twenty years ago the accepted scale of ordinary publication in India as here was one-inch. He did not know that the Anglo-Indian members of the Committee ever contemplated any other, but Sir John Farquharson, who came from this country, told them that the Survey at home had now produced a half-inch map which had become very popular and useful, and he (Sir John Farquharson) thought that in the interests of economy and expedition it ought

seriously to be considered whether publication on the half-inch scale instead of the one-inch ought not to be recommended. He did not himself recommend it, but merely said it was a matter for the Indian members of the Committee to consider. The Committee decided against it, and in favour of a publication on the one-inch scale. Since then he (the speaker) had become much more conversant with the half-inch, and occasionally he had wondered whether their conclusion was right. On the whole he thought it was. But whether it was right or not, he was quite sure under the conditions of India at that time, and looking to the evidence they received, no other decision was possible. It seemed now, he gathered from the Paper, that the Government of India had decided in many cases only to publish on the half-inch scale, and he thought that was no doubt a very wise decision, for the reasons given by Colonel Winterbotham. While maps on the one-inch scale were very useful for all those interested in a particular locality, they were much too big for others. In this country even the half-inch was found uncomfortably large for many purposes. An enormous number had to be carried on a motor journey. What should take the place of the half-inch in India? He thought that in a country so open, where there was so little complexity of road to be shown, probably a quarter-inch was as large as was required by the ordinary person, and it was with some regret he saw that only one-third of the number of the quarter-inch maps required had yet been produced. The publication of these maps must necessarily lag behind the publication of the one-inch, but he thought that every effort should be made to keep the publication of quarter-inch maps as closely abreast of the one-inch as might be possible.

Sir Louis W. Dane, G.C.I.E., C.S.I., said that he presumed that the Chairman had asked someone from the Punjab to speak on behalf of the general public because there happen to be so many Punjab officers present. He was not the oldest of these but perhaps might be allowed to speak for them, especially as the lecturer had also asked him to say something about their provincial system of cadastral survey, which was rather unique in its way. It was curious that there were present in the room three ex-Lieutenant-Governors of the Punjab, and a Financial Commissioner, all of whom were for years survey and settlement officers. Also the first map shown on the screen was the old map of the Punjab by Sir T. Roe, dating from early in the 17th century, and one of the latest maps shown was that of Lahore, the capital of the Punjab, and its surroundings, so perhaps on this occasion the Punjab might speak for the public. At any rate they could all testify to the great debt which, as revenue officers, administrators or diplomatists, they owed to the Survey of India. But for the Survey and their admirable maps their own work would have been hardly possible. Whatever success they had attained was largely due to the labours of the Survey Department.

Before dealing with local surveys he would like, with all respect, to offer one criticism of the work of some survey officers, which he had come across. They were so accurate and exact that they could not tolerate an incomplete map. In frontier questions, where surveys had not been completed or borders settled, this was often very inconvenient; he could remember cases in frontier disputes where the other side had produced our maps as evidence against us of a very awkward character. He remembered discussing the matter with Col. Long, the Surveyor-General, and at last he agreed in such cases not to have a closed border, or only an indefinite colour wash, even with the result of an incomplete map. Where things were not settled an open border was sometimes useful. Perhaps he might quote two cases on the border of the Peshawar District which it fell to his lot as settlement officer to map for the first time in 1892-96. It had always been a question whether

the head of one of our large canals was within or without the administrative border. The Khan or chief of that tract, with whom Sir L. Cavagnari had had serious differences, met him and they had a pleasant walk. In the course of this he said by the way, " Is not this bluff the border line ? " " Oh no," he replied, " it is that bluff." Thereupon an excited argument occurred. Eventually he accepted the bluff that was pointed out, but his own bluff won, as the head of the canal was left well inside the border, which was duly mapped. A considerable area near the Buner border had been left out in the previous settlement, which occurred not long after the Ambela affair. He started a party of a Sikh Naib Tahsildar and six patwaris on this area. It was a ticklish job and they were very brave men. They mapped the area all right and it was now part of the Peshawar District. Their village maps were usually signed by the headmen on both sides of the border of the village, and he had to explain that in this case it was hardly possible to get the signatures of the trans-frontier men as they could not write, but that he could personally testify that the survey had been watched and accompanied by hundreds of them, armed to the teeth, and that it was certain they would not have let the patwaris include any land to which Peshawar had not a full title.

It was perhaps worth noting as an instance of how things had changed that in this demarcation of the border his patwaris and himself had no guard except one orderly to hold his horse, and yet even throughout the Malakand affair they were out close up to the border surveying. The knowledge that he had there acquired enabled him to give information to Sir Bindon Blood as to a route which considerably helped the concentration against the Malakand. In Pathan countries to be unarmed was often to be well armed ; he carried no arms when in Afghanistan in 1904-05, though then of course he had an Afghan guard.

Now as to their Punjab squares. After the beautiful technical processes of the Survey of which they had seen specimens, it seemed almost ludicrous to talk of their own humble efforts. For some reason or other, perhaps provincial pugnacity, but rather paucity of officers, he believed they were never able to get help in the early days from the survey for their village maps, as other provinces did. The consequence was that in this survey work, as in other respects, the Punjab officers had to be jacks of all trades and perhaps masters of none. They had to learn how to make maps and then to teach the village patwaris. Col. Wace, the Financial Commissioner, in about 1884 had the excellent idea of teaching the patwaris how to correct existing maps, so that periodical complete resurveys should not be necessary. The district was to be covered with squares of 200 kadams a side, and then the old settlement maps, made by the temporary surveyors with the plane table and triangulation—and very nice maps to look at many of these were—were tested on the squares. If the survey had been badly fudged the village was remeasured ; if not, the old map was corrected by the squares and trifling differences in the internal lengths of field boundaries were neglected. It was a very difficult job, as could be imagined. The vernacular term for a square was murabba, and it was also the word for jam, but their squares were anything but real jam, even though it were to be consumed with special home-made bread patented by Colonel Wace for settlement officers' wives. Though he had been spared this diet, he was one of the first victims of the new system, and his difficulties were not lessened by the fact that in his district, Gurdaspur, there were no less than three units of measurement, and he had under the orders to retain all three. Their unit was the double pace or kadam. The length of this varied with the height of the people from 54" in the east, where they were shorter, to 60" further west. It occurred to the revenue authorities to make a double pace of 66", so that the chain of ten kadams or paces should measure 55' and the local land measure or ghumao should equal an acre. For statistical

purposes this was perhaps excellent, but for men with short legs it was difficult to pace out an area roughly. It was considered to be necessary to adhere to the local measures of area to which the people were accustomed. They also had to give up the plane tables and rely entirely on a chain, rough cross staff and flags, with a reed basket for the papers and a rough board for the mapping sheet with machine-ruled squares. The abolition of the plane table was a mistake, as a man cannot really map well squatting on the ground, and most patwaris made rough tables for themselves. Besides, in hill tracts as existed both in Gurdaspur and Peshawar they had to use plane tables. He was afraid, too, that though the system of regular and continuous correction of the field maps helped in their revenue record system, it had not obviated a general revision of these amounting almost to a resurvey at a reassessment. Like most reformers they tried to do too much. Col. Coldstream had referred to the very minute fields shown in the village maps. Sub-division of holdings was, of course, one of the curses of India, but one reason for the separate mapping of each cultivated plot as a field number was to be found in the fact that the temporary surveyors had to map a certain number of fields a day. They started in to reduce these superfluous numbers by mapping all the area held by one owner or occupancy tenant in one place on a distinct tenure as a field number. This resulted in the production of impossible polygonal fields which made crop inspections hopeless. He remembered one case where he started out to make a crop inspection on one of the new maps in a riverain tract. The custom there was that all land brought over by the deep stream rule was for some years treated as common land belonging to all the village proprietors. A whole village had come over, and quite in accordance with the rules, being land owned by the same owners on a distinct tenure, the whole area of some hundreds of acres was mapped as one field number, and, of course, crop areas could only be ascertained by separately pacing each crop sown, and the map was useless. Eventually the rule was modified so that fields must not be so irregularly shaped or so large that a patwari could not estimate up the crops sown conveniently from one position. Even with this they got rid of about half the old numbers in a closely populated tract, which much reduced statistical work.

Fields often present difficulties in mapping. In Peshawar, in unirrigated tracts, they still kept up the old tribal practice of giving each owner a long strip of land running right across each division of a village, so that each might get his share of good and bad land. By sub-division some of these strips had come to resemble the definition of a line—length without breadth—being perhaps half a mile or even a mile long by a yard or so wide. To delineate this sort of thing on a map, no matter how large the scale, was was almost impossible. Such areas were ploughed and sown in common, and when harvest arrived a greybeard went round, and starting from some known feature on the ground, measured out each man's share by cubits, ox-goads, ropes, paces or whatever the local practice was, and so the harvest was cut. They decided to map in accordance with the practice; each section of strips was mapped in one field covering all the numbers included in it, and a note was entered in the field register showing from which direction the fields ran, and what method of measurement was followed to determine the area to be reaped by the owner of a particular number. He believed it worked well in practice, and the maps ceased to represent a network of lines, the position of which no one could possibly ascertain, so that disputes were hopeless.

However, the squares, and their successors the rectangles of 25 acres each, were a splendid success, and the whole Punjab was now a chessboard of them, based in some cases on traverses by the Survey Department. A refinement was to carry the series of squares from one village to another to prevent boundary disputes

Then in riverain tracts longer base lines for a series of squares covering a considerable area were laid down. This principle was also adopted in the Canal Colonies. In Peshawar he rather attempted the impossible. The district was circular in shape and much cut up by rivers. They selected a central point and an irrigation engineer laid out a few miles of base lines N, S, E, and W from this, and then they carried these on throughout the district. The longest line was about 60 miles, and it was carried across a bare tract in the heat of a frontier summer. They worked at night and the direction was obtained by flares on posts. The chaining was carried out by daylight, and the whole system tied back as they went along by chained diagonals. At the extreme east end they found that they were about 100 yards out, but he understood that this rather proved the extraordinary accuracy of east and west alignment than otherwise. All the village maps, of course, fitted into one large map which was found useful for military purposes, he believed. It was a rash experiment and a terrible business getting out lines across the rivers, and he did not recommend anyone else to try it without technical assistance, but at any rate it apparently stopped all boundary quarrels, which used to be frequent. He thought that a glimpse of the huge district maps all on one series of squares was enough to terrify any litigant.

It was surprising, considering their rudimentary appliances, how extraordinarily accurate the field work was. He remembered the astonishment of Col. Codrington of the Survey, on testing some of the work, and Baron de Dedhem, Governor of the Dutch Indies, was so pleased with the system that he took their rules to introduce them there. The patwari had infinite patience, and like most Indians when properly treated was capable of excellent work, in which he took a proper pride. There were exceptions, of course, and he acquired a reputation for almost supernatural intelligence by fining a patwari for not accompanying the chainmen, when, so far as they knew, he was nowhere near. The fact was that from the train he saw his friend sitting in the shade of a tree doing his map at his ease, while the chainmen reported the measurements. He was a lazy fellow and the example did good. Opinions would vary as to the merits of this Punjab system, but at any rate the Settlement Officer, while tramping for miles daily checking measurements, gained by the sweat of his brow a knowledge of the people and of the agricultural capacity of his villages which no other officers could acquire, and this was all for the good. He also could realise some of the much greater difficulties which confronted the officers of the Survey of India, so on behalf of his fellow humble village surveyors he ventured to offer their tribute of praise and admiration to that great Department whose work had been so well brought before them by the lecturer.

At the conclusion of the meeting a vote of thanks was warmly accorded to Col. Coldstream, on the motion of the Chairman.

Sir Edward Gait, K.C.S.I., C.I.E., who was unable to remain for the discussion, writes: I do not think there can be any possible doubt as to the accuracy of the statement that the drawer of the map of India, based on information collected by Sir Thomas Roe, which, we are told, was originally published in England in 1619, was the William Baffin of North West Passage fame. It is known that, after his last voyage to the Arctic Ocean, he entered the service of the East India Company and did some valuable survey work in the Persian Gulf and elsewhere. He reached Surat in 1617, while Sir Thomas Roe was still in India, and died in 1622 of wounds received in an attack on Kishm, at the entrance to the Persian Gulf.

It is a pity that this map of India is not so well known as the Portuguese and Dutch maps of De Barros, Blaev and Van den Broucke, which were issued a few years later.

NOTES ON BOOKS.

METALLURGY AND ITS INFLUENCE ON MODERN PROGRESS. By Sir Robert A. Hadfield, Bt., F.R.S., etc. London: Chapman & Hall, Ltd. Pp. XVI. 388. 25s.

Ever since he emerged from the Stone Age, the progress of man has depended more, perhaps, than upon anything else, on his knowledge and skill in the working of metals, and this is as true to-day as it was in the earliest stages of civilisation. It is, therefore, particularly interesting to find one of the pioneers of the most modern development of metallurgy—the "alloy steels"—devoting his attention to this question. In the book under review, Sir Robert Hadfield has not dealt with the progress of metallurgy in general, but has given rather a detailed account of those lines of progress in which his own activities have lain and of which he speaks with first-hand knowledge. What the book lacks in balanced impartiality, therefore, it gains to a considerable extent in personal interest.

After paying tribute to the work of the giants of the past, the author tells the story, first of manganese steel and then of silicon steel with much vivid detail. In these days of advanced and widespread metallurgical research, when materials possessing startling properties are produced every year, it is difficult to appreciate to the full the position as it existed before Hadfield's discovery and development of manganese steel gave the engineering world what was essentially a new type of constructional material. Here was a steel which, when quenched from a high temperature, instead of becoming glass hard, remained in a tough and ductile state, in which, however, it was ever ready to protect itself from abrasion—for instance—by a wonderful power of local self-hardening. So-called "austenitic" steels are now well known and their constitution fairly well understood, but at the time of Hadfield's discovery the subject was clouded by the bitter feud between allotropists and carbonists. That feud has been killed by the advent of new knowledge, but it is somewhat curious to find echoes of it still in Sir Robert's book.

Silicon steel, although less sensational than manganese steel, is perhaps industrially the more important of the two. The saving of power losses in electric machinery and especially in transformers is a matter of immense importance, and one which, to judge from the whole tenour of his book, and particularly from his treatment of the subject of fuel economy, is particularly dear to Sir Robert Hadfield's heart. The modern development of corrosion-resisting steels, in which Sir Robert is also actively engaged, serves a similar aim—that of conserving the natural resources at the disposal of man.

The book before us covers a wide field, both as regards time and subject, and it neither claims nor aims to be a systematic treatise. For the expert metallurgist it serves a useful purpose in collecting together much scattered information about the two types of steel with which the name of Hadfield is associated, and many interesting historical details about their origin and development. If he—or the general reader—has the necessary leisure to follow Sir Robert through the purely historical portions and to study the sections relating to education and research, he will find much that is interesting and stimulating. The author is clearly alive to the urgent need of continued research and makes some interesting suggestions as to its possible future direction. Research, however, will and must go its own way unhampered; all that the most stimulating author can hope to do is to point out a few promising starting points for further exploration. The young metallurgical researcher will be fortunate if he strikes a field as rich as that upon which Sir Robert Hadfield was able to work—or exploits it as successfully.

ARCHITECTURE. By Alfred Mansfield Brooks. Introduction by Sir Reginald Blomfield. Boston: Marshall Jones Company.

This little volume forms one of a series entitled "Our Debt to Greece and Rome," edited by Dr. George Depue Hadzsits, of the University of Pennsylvania, and Dr. David Moore Robinson, of the Johns Hopkins University. No attempt is made to give a detailed account of Greek and Roman architecture—the prescribed size of the book renders this impossible; but Professor Brooks has attempted—and he has succeeded wonderfully well in his attempt—to make his readers realise something of the spirit which animated classical architecture. In all this he preaches a lesson which might well be taken to heart to-day. From beginning to end no trouble was too great for the Greek workmen and architects. "The intense care which they bestowed upon laying and bonding stone, whether the blocks of a wall or the drums of a column, is but one of many proofs of the high regard they had for technique." When columns were being built, the horizontal surfaces which touched each other were chiselled and polished to absolute smoothness. And this infinite capacity for taking pains was characteristic of the whole of Greek architecture in its palmiest days. The Parthenon, for instance, was full of the most subtle refinements. Slightly curving line and surface took the place of mathematical straightness, flatness and verticality. To show how slight these "refinements" were, one need only mention that in the length of 100 feet across the base the rise of the curve is less than three inches, while in the length of the sides, 225 feet, the rise is only four inches; and yet such exceedingly small variations were enough to make the difference between consummate art and mechanical workmanship.

Considering the limited space at his disposal, Professor Brooks has contrived very successfully to impress upon his readers what it was in the Greek spirit that led to such astonishing results. We regret that it was not possible to include a few good plates. Architecture is a subject which pre-eminently calls for illustration and some of the author's descriptions, excellent though they are, would have gained much in clearness and interest had they been explained by a plan or an elevation.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 p.m. (except where otherwise stated):—

FEBRUARY 24.—MARGARET FISHENDEN, D.Sc., F.Inst.P., Fuel Research Division, Department of Scientific and Industrial Research, "Domestic Heating." PROFESSOR LEONARD ERKINE HILL, M.B., F.R.S., in the Chair.

MARCH 3.—PERCY DUNSHEATH, O.B.E., M.A., B.Sc., M.I.E.E., Chief of Research Department, W. T. Henley's Telegraph Works Co., Ltd., "Science in the Cable Industry." LLEWELLYN B. ATKINSON, M.I.E.E., in the Chair.

MARCH 10.—REINHARDT THIESSEN, Ph.D., of the Bureau of Mines (U.S. Department of the Interior), "The Microstructure of Coal." SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, in the Chair.

MARCH 17.—LIEUT.-COLONEL JOHN HERBERT BORASTON, C.B., C.B.E., "Co-Partnership." VISCOUNT CECIL OF CHELWOOD, P.C., K.C., in the Chair.

MARCH 24 (at 4.30 p.m.)—SIR FRANK BAINES, C.V.O., C.B.E., Director of Works, H.M. Office of Works, "The Preservation of Folk Architecture in this Country."

APRIL 14.—R. A. DAWSON, A.R.C.A. (London), Principal, Municipal School of Art, Manchester, "Art Training for Industry, and the Society's Competitions." SIR FRANK WARNER, K.B.E., in the Chair.

April 21.—Major-General Sir George McMunn, K.C.B., K.C.S.I., D.S.O., " Some Aspects of the Business Side of an Army."

Dates to be hereafter announced :—

C. F. Elwell, B.A., " Progress in the Radio Art : A Survey of Accomplishment and Possibilities of Future Development."

James Paterson (of Messrs. Carter Paterson & Co., Ltd.), "Horse Traction and Motor Traction."

Monsieur Van Cauwelaert, Burgomaster of Antwerp, " The Port of Antwerp."

Ralph John Pugh, "British Film Production."

Indian Section.

Friday afternoons, at 4.30 o'clock.

March 19.—Lady Chatterjee, O.B.E., M.A., D.Sc., " Women and Children in Indian Industries." The Viscountess Chelmsford, G.B.E., in the Chair.

Dates to be hereafter announced :—

Herbert Baker, A.R.A., F.R.I.B.A., " The New Delhi."

Joseph Charles French, I.C.S., " Buddhistic Art in Bengal."

Dominions and Colonies Section.

Tuesday afternoons, at 4.30 o'clock.

March 2.—Sir Basil Clarke, Managing Director, Editorial Services, Ltd., late Director of Publicity, Ministry of Reconstruction, Ministry of Health, and Irish Office, etc., " Publicity in relation to the Problems of Empire Settlement and Trade." The Right Hon. Viscount Burnham, C.H., LL.D., D.Litt., in the Chair.

May 4.—Charles Ponsonby, Managing Director, British Central Africa Company, " Nyasaland." Brigadier-General Sir S. H. Wilson, K.C.M.G., K.B.E., C.B., Permanent Under-Secretary of State for the Colonies, in the Chair.

Date to be hereafter announced :—

Senor Bolin, " Spanish North Africa." His Excellency the Marques Merry del Val, Spanish Ambassador, in the Chair.

Indian and Dominions and Colonies Sections (Joint Meeting).

Friday, April 16th, at 4.30 o'clock.—Lieutenant-General Sir W. T. Furse, K.C.B., D.S.O., Director, Imperial Institute, " The Work of the Imperial Institute."

Cantor Lectures.

Monday evenings at 8 o'clock.

G. W. C. Kaye, O.B.E., M.A., D.Sc., Superintendent, Physics Department, National Physical Laboratory, " The Production and Measurement of High Vacua." Three Lectures. February 15, 22, and March 1.

Lecture II.—Molecular pumps. Diffusion and condensation pumps. All-metal mercury-vapour pumps. Absorption and adsorption methods of exhaustion. " Clean-ups " and " getters." Hardening of discharge tubes.

Lecture III.—The measurement of high vacua. The McLeod gauge. " Damping " gauges. Molecular gauges. Pirani gauge. Knudsen's gauge. Ionisation gauges. The measurement of pump speeds.

W. F. Higgins, M.Sc., National Physical Laboratory, "Thermometry." Three Lectures. March 15, 22, and 29.

Lecture I.—Introduction. Development of the thermometer from the early type of thermoscope. Early books on the subject of thermometry. Primary standard mercury thermometers. Calibration corrections. Correction to the gas thermometer scale of temperature.

Lecture II.—Thermometric glasses. Secular change. Depression of the Zero after heating. Anneal effects. Types of thermometers in common use. Chemical thermometers. High range thermometers. Meteorological thermometers. Clinical thermometers.

Lecture III.—Points of importance in the use of thermometers. Correction for emergent column. Thermometric lag. The standardisation of thermometers. Apparatus used for comparisons of thermometers. Water baths. Oil Baths. Baths of fused salts. The trend of future developments.

Charles Reed Peers, C.B.E., M.A., Director S.A., Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." Three Lectures. April 19, 26, and May 3.

Lecture I.—Definitions. The value and intention of ornament. Prehistoric ornament. Bronze Age. Hallstatt and La Téne. Classic and barbarian art. Lines of communication. Trade and invasion. The Roman conquests. Late-Celtic Art.

Lecture II.—Roman Britain. The northern invaders. The Christian Mission. Iona and Northumbria. Benedict Biscop and Wilfrid. Offa of Mercia. Alcuin and Charlemagne. The classic revival. The Danes. The Norsemen. Alfred. Athewold and the school of Winchester.

Lecture III.—Edward the Confessor, and the Normans. The Norman Conquest. English Romanesque. The evolution of Gothic art and its use of ornament. The high-water mark. The decline.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

Monday, February 22..Actuaries Institute of, Staple Inn Hall, Holborn, W.C. 5 p.m. Mr. C. R. V. Coutts, "On the Distribution of Life Office Profits."

Faraday Society, at Burlington House, W. 5.30 p.m. Messrs. A. J. Allmand and R. H. D. Barklie, "The Influence of Alternating Currents on the Electrolytic Corrosion of Iron." Mr. A. N. Campbell, "The Direct Oxidation of Manganous Ion to Permanganate." Mr. H. J. Poole, "The Elasticity of Jellies of Cellulose Acetate in Relation to their Physical Structure and Chemical Equilibria." Messrs. F. G. Tryhorn and W. F. Wyatt, "Adsorption II. The Adsorption by a Coconut Charcoal of Saturated Vapours of some Pure Liquids." Messrs. F. G. Tryhorn and W. F. Wyatt, "Adsorption III. Stages in the Adsorption by a Coconut Charcoal from the Saturated Vapour over Liquid Mixtures of Alcohol and Benzene and of Acetone and Benzene." Mr. I. R. McHaffie, "A Device for Circulating Fluids under High Pressure."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Mr. A. F. Harmer, "Some Changing Characteristics in the Application of Electricity to Public Supply."

At Armstrong College, Newcastle-on-Tyne. 7 p.m. Messrs. J. L. Thompson and H. Walmsley, "Notes on the Testing of Static Transformers."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Mr. and Mrs. Visser, "The Glaciers of Hunza."

Société Internationale de Philologie, Sciences et Beaux Arts, 8, Taviton Street, W.C. 3.30 p.m. Admiral J. N. Thompson, R.N., "Arctic Exploration."

Structural Engineers, Institution of, at the Chamber of Commerce, Birmingham. 7.30 p.m. Mr. H. F. Lea, "Arterial Road Construction."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. A. S. Eddington, "The Constitution and Evolution of the Stars." (Lecture I.)

At University College, Gower Street, W.C. 4.30 p.m. Mr. Henry Higgs, "Some Social Problems in the Light of Economics and Statistics." (Lecture VI.); 5.30 p.m. Prof. J. H. Morgan, "The Dominions and Foreign Policy." (Lecture I.); 5.30 p.m. Mr. M. H. Krishna, "Indian Archæology and Anthropology." (Lecture VI.); 5.15 p.m. Dr. R. W. Lunt, "The Chemistry of Ionization by Collision." (Lecture IV.)

At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture IV.); 5.30 p.m. Prof. Gaetano Salvemini, "The Political Evolution of Italy in the Nineteenth Century." (Lecture IV.)

At University College, Gower Street, W.C. 4 p.m. Prof. A. V. Hill, "The Physiology of Muscle." (Lecture IV.); 5.30 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture V.).

At St. Thomas's Hospital Medical School, Albert Embankment, S.E. 5.30 p.m. Prof. Dr. D. Murray Lyon, "Some Principles of Therapeutics." (Lecture I.)

Tuesday, February 23..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.15 p.m. Mr. R. E. Enthoven, "Ethnographic Research in India."

Asiatic Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.30 p.m. Sir E. D. Ross, "The Fables of Bidpai in Persian Literature."

Aeronautical Engineers, at 39, Victoria Street, S.W. 6.30 p.m. Informal Meeting.

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. Victor Bayley, "The Khyber Railway." Col. Gordon R. Hearn, "The Survey and Construction of the Khyber Railway."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. F. S. Clifford, "The Principles and Practice of Automatic Steering."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. Alexander Keighley, "Palestine."

Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Dr. E. H. Griffin, "Rheumatism."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Barcroft, "The Shell of the Egg."

University of London, at the London School of Economics, Aldwych, W.C. 5 p.m. Mr. F. W. Hirst, "Adam Smith and the Development of English Fiscal Policy."
At University College, Gower Street, W.C. 5.30 p.m. Prof. G. S. Gordon, "The Youth of Milton." (Lecture III.)
At the Institute of Historical Research, Malet Street, W.C., 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture VI.)
At St. Thomas's Hospital Medical School, Albert Embankment, S.E. 5.30 p.m. Prof. Dr. D. Murray Lyon, "Some Principles of Therapeutics." (Lecture II.)
At Birkbeck College, Fetter Lane, E.C. 5.30 p.m. Prof. J. Plattard, "Ronsard et ses amis à l' Université de Poitiers."

Zoological Society, Regents Park, N.W. 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, FEBRUARY 24..Geological Society, Burlington House, W. 5.30 p.m. Miss G. L. Miles, "The Geological Structure of Ben Lawers and Meall Corranaich (Perthshire)."

Mechanical Engineers, Institution of, at the Department of Applied Science, Sheffield, 7.30 p.m. Informal discussion on "What is Wrong with Industrial England?"

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. Demonstration of Eastman Colorimeter; 8 p.m. Mr. C. A. Klein, "The Application of the Microscope to the Examination of Pigments and Paints."

Master Glass-Painters, British Society of, at 6, Queen Square, W.C. 5.30 p.m. The Very Rev. Dr. J. Armitage Robinson, "The Windows of the Lady Chapel at Wells."

Royal United Service Institution, Whitehall, S.W. 3 p.m. Commodore the Marquess of Graham, "Public Schools and the Royal Navy."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. F. J. C. Hearnshaw, "Benjamin Disraeli, Earl of Beaconsfield."
At King's College, Strand, W.C. 5.30 p.m. Prof. A. S. Eddington, "The Constitution and Evolution of the Stars." (Lecture II.); 5.30 p.m. Prof. A. S. Peake, "The Servant of Yahweh." (Lecture I.)
At University College, Gower Street, W.C. 5.30 p.m. Dr. J. Haantjes, "Modern Dutch Novelists"; 5.30 p.m. Mr. J. H. Helweg, "Literary Criticism in Denmark in the XIXth Century." (Lecture III.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Earliest Civilisation of the Slavs." (Lecture VI.)
At St. Thomas's Hospital Medical School, Albert Embankment, S.E. 5.30 p.m. Prof. Dr. D. Murray Lyon, "Some Principles of Therapeutics." (Lecture III.)

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. Earnst Herzfeld, "Pre-Achæmenian and Achæmenian Persia." (Lecture I.)

THURSDAY, FEBRUARY 25..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Aeronautical Society, 7, Albemarle Street, W. 6.30 p.m. Mr. A. J. Cobham, "Long Distance Aeroplane Flights."

China Society, at School of Oriental Studies, Finsbury Circus, E.C. 5 p.m. Mrs. Ayscough, "T'ai Shan: Peak of the East."

Electrical Engineers, Institution of, at Trinity College, Dublin. 7.45 p.m. Prof. Dr. S. P. Smith, "An All-Electric House."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7 p.m.

L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. E. Hawking, "Furnishing Problems, Past and Present."

Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. C. D. Ellis, "The Atom of Light and the Atom of Electricity."

Royal Society, Burlington House, W. 4.30 p.m.

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Mr. William King, "David Garrick."

University of London, at the London School of Economics, Aldwych, W.C. 5.30 p.m. Dr. Walter W. Seton, "The Development of Scotland in the XV. and XVI. Centuries." (Lecture II.)
At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Customary Law in Europe." (Lecture V.); 3 p.m. Prof. E. G. Gardner, "The Purgatorio of Dante." (Lecture VI.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk-Mirsky, "Early Russian Literature." (Lecture VII.); 4 p.m. Mr. I. L. Evans, "Economic Development of South Eastern Europe." (Lecture IV.)
At King's College, Strand, W.C. 5 p.m. Dr. J. A. Hewitt, "Metabolism of Carbohydrate and Fat." (Lecture VI.)

FRIDAY, FEBRUARY 26..Chadwick Public Lectures, at the Institution of Civil Engineers, Great George Street, S.W. Dr. H. T. Calvert, "The Activated Sludge Process of Sewage Treatment."

Société International de Philologie Sciences et Beaux Arts, 8, Taviton Street, W.C. 8.15 p.m. Lieut.-Colonel Mansfield, "New Light on Columbus."

Physical Society, at Imperial College of Science, South Kensington, S.W. 5 p.m. Mr. J. E. Calthrop, "The Effects of Torsion upon the Thermal and Electrical Conductivities of Aluminium, with special reference to Single Crystals." Mr. T. H. Harrison, "A Study of the Concurrent Variations in the Thermionic and Photo-electric Emission from Platinum and Tungsten, with the State of the Surfaces of these Metals." Messrs. Chas. R. Darling and Edwin Edser, Demonstrations illustrating Surface Tension and Capillary Phenomena.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Dr. C. Hagberg Wright, "Nicolas de Peiresc and his Circle."

Transport, Institute of, at the Midland Hotel, Manchester. 6.30 p.m. Mr. A. Hacking, "Some Financial and Political Aspects of Highway Development."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. Ruggles Gates, "Vegetation on the Amazon." (Lecture II.)
At University College, Gower Street, W.C. 5.30 p.m. Miss Eleanor Hull, "Ireland from the Earliest Times." (Lecture VI.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Making of Modern Roumania." (Lecture IV.)
At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. Graham Wallas, "Social Leadership." (Lecture III.)
At Birkbeck College, Fetter Lane, E.C. 5.30 p.m. Prof. J. Plattard, "L'esprit de la Renaissance dans l'oeuvre de Rabelais."

SATURDAY, FEBRUARY 27..L.C.C., Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. G. C. Robson, "Squids, Cuttlefishes and their Allies."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. G. Macdonald, "Roman Britain." (Lecture II.)

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FRIDAY, FEBRUARY 26th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, MARCH 1st, at 8 p.m. (Cantor Lecture.) G. W. C. KAYE, O.B.E., M.A., D.Sc., Superintendent, Physics Department, National Physical Laboratory, "The Production and Measurement of High Vacua." (Lecture III.)

TUESDAY, MARCH 2nd, at 4.30 p.m. (Dominions and Colonies Section.) SIR BASIL CLARKE, Managing Director, Editorial Services, Ltd., late Director of Publicity at the Ministry of Reconstruction, Ministry of Health, and Irish Office, etc., "Publicity in relation to the Problems of Empire Settlement and Trade." THE RIGHT HON. VISCOUNT BURNHAM, C.H., LL.D., D.Litt., will preside.

Tea will be served in the Library from 4 p.m.

WEDNESDAY, MARCH 3rd, at 8 p.m. (Ordinary Meeting.) PERCY DUNSHEATH, O.B.E., M.A., B.Sc., M.I.E.E., Chief of Research Department, W. T. Henley's Telegraph Works Co., Ltd., "Science in the Cable Industry." LLEWELLYN B. ATKINSON, M.I.E.E., will preside.

TENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 17th, 1926. ADMIRAL OF THE FLEET SIR HENRY JACKSON, G.C.B., K.C.V.O., D.Sc., LL.D., F.R.S., in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

Dixon, Leon Snell, Bangor, Maine, U.S.A.
Qureshi, Dr. M. Y. Badr, B.A., Jhang, Punjab, India.
Tiwari, Nagendra Mohan, B.Sc., LL.B., Batia State, India.

The following candidates were duly elected Fellows of the Society:—

Benton, Clifford, London.
Corbett, Charles Foster, Edmonton, Alberta, Canada.
Mathur, Achleshwar Nath, Alwar, India.

Savage, John Arthur, London.
Steven, Robert Ernest, São Paulo, Brazil.
Whitehouse, J. Howard, Bembridge, Isle of Wight.
Whittaker, Captain Harry (late R.E.), B.Sc., Lahore, India.

A paper on "The Propagation of Electric Waves" was read by JAMES EDWARD TAYLOR, Superintending Engineer, Post Office Telegraphs, etc., South Midland District.

The paper and discussion will be published in the *Journal* dated March 19th.

CANTOR LECTURE.

MONDAY, FEBRUARY 22nd, 1926. G. W. C. KAYE, O.B.E., M.A., D.Sc., Superintendent Physics Department, National Physical Laboratory, delivered the second of his course of three lectures on "The Production and Measurement of High Vacua."

The lectures will be published in the *Journal* during the Summer recess.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

WEDNESDAY, JANUARY 27TH, 1926.

SIR HALFORD JOHN MACKINDER, Chairman of the Imperial Shipping and Imperial Economic Committees, in the Chair.

THE CHAIRMAN, in introducing the lecturer, said he should listen with the greatest interest to the reading of the paper, with the object of learning. On the Imperial Economic Committee, over which he had the honour to preside, one obtained a lawyer's knowledge of things. A lawyer's knowledge, of course, was no real knowledge, and yet it was extraordinarily accurate knowledge. It was not a knowledge of things, but, because that sort of knowledge was obtained on oath and as the result of cross-examination, it should be accurate. The members of the Imperial Economic Committee had a great deal of help given them by many, both practical and scientific people. He did not mean to say that those were alternatives; they ought to be the same. They did, therefore, obtain a certain amount of knowledge which they attempted to codify and to place before the Governments of the Empire. There was one idea which had struck him when the Imperial Economic Committee had begun its study of the marketing of the fruit supplies of the Empire, namely, the fact that fruit differed from most other things brought across the seas in that it was a living thing; and once that idea was grasped—that it was something living though separated from the tree, and was therefore liable to disease—a good deal had been learned. On looking over the epitome of Professor Thompson's lecture he had found yet another illuminating expression, that the fruit was a "living passenger" which the shipowner had to carry. As far as he could see, the

audience were going to listen that night to a discussion which really turned on that illuminating idea—from the moment a fruit left the farm until it reached the table of the consumer it was a living passenger, and must be provided for as other living things must be provided for, and not as a dead thing.

The following paper was then read:—

SOME GENERAL PROBLEMS OF THE TRANSPORT BY SEA AND CONSERVATION IN STORE OF RIPE FRUIT.

By Professor J. McLean Thompson, M.A., D.Sc., F.L.S., F.R.S.E., of the University of Liverpool.

The standpoint adopted in these pages is based primarily on the belief that for every comestible fruit natural ripening should, if possible, be secured before transport and storage are attempted. This view is founded on the fact that at least the vast majority of the fruits which are prized either as food or delicacies attain to the full their most conspicuous qualities only when natural ripening has been permitted. Such ripening is in large measure attained for oranges, and commonly in full for apples. The consumer is accordingly familiar with these fruits in their natural maturity, and indeed it may be affirmed that the average citizen of these islands is as familiar with the full flavour and appearance of perfect American apples or Valencia oranges as are many of the inhabitants of the United States or of Spain. It is a common belief that special virtues are possessed by certain of our common fruits only when natural ripening has occurred.

There are, however, many valuable and important fruits such as bananas and pineapples which are almost unknown at true maturity by the western world. This is due to the common belief that such fruits cannot be preserved in natural ripeness during even short periods of transport and store, and indeed it is common experience to all who have handled such fruits that degradation may be rapid from maturity onwards despite careful packing and expeditious transport. Such fruits are believed to be naturally less liable to decay and to many forms of disease if harvested while still immature, and artificially ripened partly in the holds of ships and partly after disembarkation. The flavour and qualities of such fruits are generally admitted by those who are familiar with the naturally matured products of the tropics to be distinctly inferior to those of the latter. In some instances there are subtle but distinct differences between the naturally ripened and artificially ripened fruits which place the latter in a class of both inferiority and deficiency. There is reason to believe that the courses of natural and artificial ripening are frequently as different as are the fruits themselves. The examples above mentioned serve to illustrate a group of well known vegetable products of definite food value and of considerable economic importance.

But even with oranges and apples which have been naturally ripened or which have approached maturity before they have been harvested it is common-

ly unsafe to prolong either a railway journey or a sea voyage beyond a very limited period. Thus for example important losses are frequently incurred during the transport of apples from the Pacific to the Atlantic coast of North America should delay at any point occur during a period of warm weather or in the eastern ports prior to shipment. Or again in the transport of Valencia oranges to the Port of Liverpool marked deterioration is all too frequent should the voyage be continued beyond ten days. This would appear to be more commonly the case, even at the beginning of the orange season, after a wet summer in Spain. The fruit may then be watery in excess and its keeping powers appear to be readily impaired. A survey of the sale bills of Liverpool Fruit Exchange for the season 1924-25 provides clear proof of the degrading of oranges during transport by sea. It is true that the majority of the ships engaged in the carrying trade of such fruit to Liverpool are not provided with apparatus which may especially contribute to the preservation of soft fruits. Nevertheless strict observation is kept on the fruit during transport, and all that is possible with the means and personnel available is done during these short voyages. The case of Valencia oranges is not unique in the practice of fruit transport during short sea-voyages. It serves, however, to illustrate the point that the danger limit is commonly closely approached and may be readily overstepped even with fruits of general consumption and of considerable importance during a brief voyage under climatic conditions of no great severity. But there are many important and valuable tropical fruits which have been considered incapable of transport either in ripeness or immaturity, and which are in consequence virtually unknown in Europe. Such for example are the guava, the mangosteen and certain varieties of mango. In natural ripeness some of these are magnificent and highly valuable fruits easily available for cultivation, and indeed widely grown in the tropics. They represent a class of abundant and varied food material which awaits exploitation. It is true that during recent years the mango has reappeared in the British market, but to those who have known the best varieties of this fruit in the tropics, grown in abundance and available at almost nominal cost, it has been a matter of some surprise to encounter these fruits in marked immaturity and at considerable price on the retail counters. Were the qualities of the mangosteen really widely known and means of transport beyond Aden provided, the consumer would be more fully alive to the possibilities of fruit-qualities to be explored.

But even with such fruits as apples and oranges it is frequently considered unsafe to transport on a large scale under conditions of temperature, humidity and aeration which prevail in temperate or sub-tropical climes. This is due to the belief that under such conditions rapid degradation must commonly arise from over-ripeness and from physiological and fungal diseases to which mature and over-mature fruits are prone. In consequence, attention has been largely directed to the development of processes which may retard ripening

or over-ripening or which may inhibit the growth of fungal organisms. To this end the methods of cold storage have been evolved. Their advantages are obvious in that they commonly retard further ripening and over-ripening and delay the growth and spread of fungal and other parasitic organisms. They undoubtedly contribute in large measure to the preservation of vast quantities of fruit over considerable periods. But among their grave disadvantages must be numbered the facts that they are commonly costly; tha tthey demand skilful operation which places their practice outside the powers and the purses of the small individual trader; that they demand atmospheric conditions—primarily of temperature—which are generally abnormal to the ripe fruit itself, and impose such conditions of suspended animation at low temperatures that the vitality of the fruit is impaired, so that rapid degradation may occur when the produce is removed from the store or ship for marketing. To all who are acquainted with the preservation of fruit during transport by sea and in store by such methods a definite category of physiological diseases is well-known. It is generally admitted that while the preservation of ripe fruit by cold storage may be prolonged, flavour may be impaired. In practice the method may provide little more than palliatives. A general awakening to the importance and value of naturally ripened fruit and to the urgent need of methods which will secure flavour and prolonged and healthy storage under normal conditions has fortunately come. Thus the shipper is no longer liable to consider himself the carrier of so much cargo. He is growingly aware of the fact that each fruit is a living passenger. The conditions of healthy life may not yet be fully expressed in the terms of a bill of lading, but the day is not far distant when the merchant will require what the shipper can provide in fuller measure than he has imagined possible. On the other hand the economic conditions of the world are driving both growers and buyers to the elimination of the appalling wastage of food materials which a decade ago they faced with comparative equanimity, and accepted as the inherent misfortune of their trade. There is, fortunately, a further realisation both by the general public and the medical authorities of the widespread dangers to which the consumer is exposed by vitiated and infected fruit. The powers of a port medical officer are wide and varied. But he can as yet no more be expected to possess a full essential knowledge of the nature and possible effects of many fungal infections which he encounters in fruit cargoes than can the consumer be aware of the variety of fruits available as food, or of the losses through disease incurred during transport and store. There are, indeed, many fungal organisms which enter our ports daily with plant produce whose nature and action are obscure and await intensive study. In this respect the nation owes a heavy debt of gratitude to both the Food Investigation Board and the Imperial Economic Committee for their strenuous campaign of enquiry and research into the causes of food deterioration and the difficulties and satisfactory methods of food preservation. Their keen appreciation of the complexity of the problems involved—for which

no purely uniform solution can be expected—and of the importance of fundamental biological and physical research for the betterment of our food supplies is well known. But it cannot be brought too insistently to public notice that it is essential to the proper handling of each individual fruit used as food for mankind that conditions of health must primarily be secured from the day of harvesting. It must further be realised by all concerned in the fruit trade that wherever readjustments in the processes of trade are shown to be desirable by research they must be readily adopted. Modifications are both essential and imminent which in the long run will benefit the fruit trade as a whole.

Among the many problems awaiting solution are these :—Can all fruits now used as food be transported in ships and later stored in dormant ripeness, as grain is stored? Can conditions of transport and store be satisfactorily devised in keeping with the normal physiology of the fruit itself? Can the maintenance of such conditions practically restrict or eliminate the diseases which are now well-known? Can the vitality of ripe fruit be prolonged in store under normal or approximately normal conditions, so that it may be abundant throughout the year, may be more varied and more widely consumed, and may be cheapened? These are merely examples of our problems and to them definite and practical answers must be given. To the first of them considerable attention has been given in the Hartley Laboratories of the University of Liverpool during the past three years, the physiology of maturity of oranges and apples being particularly studied. The course of degradation of these fruits under the conditions which prevail or may arise in the holds of ships or in stores, and the means whereby such degradation may be avoided have also been studied. Attention has also been largely directed to the effects of prolonged maintenance of uniform conditions of approximately normal temperature, aeration and humidity upon these fruits. It is essential to the understanding of the problems involved that an accurate knowledge is possessed of not only the appearance, flavour, odour and the general chemistry of the ripe fruits which are used for experimentation, but detailed information must be secured at the outset as to the physical conditions of each individual tissue of the fruit examined, and as to the general distribution in these tissues of at least a number of their characteristic substances. Thus, for example, in the case of ripe Valencia oranges the condition of the rind, the membranous skin of the fleshy segments, and the fruit vesicles must be accurately determined. The outer rind is not only firm and well coloured and contains abundant limonene in its oil cavities, and moderate amounts of calcium oxalate and of hesperidin, but the skin is well pitted over the oil vesicles, and there is a definite internal atmosphere in the small but numerous intercellular spaces of the rather thick-walled component cells. The firmness of the outer rind is due mainly to the turgidity of the thickened but elastic walls of its cells indicative of the normal healthy control of fluids in the cells themselves. The uniformity of sparkling colour is directly referable to the groupings of well defined spherical

and compact chromatophores around the nuclei of the cells, and to the granular nature of the colouring substance in the bodies of the apparently vacuolated or semi-fluid chromatophores. The calcium oxalate is readily discovered in fair abundance in crystalline form, but the hesperidin is generally observable, and that more commonly in the inner portion of the outer rind, only after precipitation has been induced. The inner rind is of the consistency of blotting paper and is usually white. Its cells are irregularly enlarged and elongated so that an extensive system of air spaces is displayed among them. Their fluid content is low, their walls are only moderately though uniformly thick, and their chromatophores are few and somewhat distended. From them calcium oxalate and hesperidin are virtually absent. There are no conspicuous features in the membranous skin of the fruit segments further than the elongation and occasional thickening of the cell walls and the general absence of both calcium oxalate and hesperidin from them. The thread-like fruit vesicles are, in mature health, characterised by a peculiar transparency despite their depth of orange colour, and by a certain viscosity of the expressed juice. The outer layer of cells of each vesicle is composed of narrow fibre-like components whose walls are, however, mainly thin. The inner cells are greatly enlarged. Their walls are so thin and distended that rupture readily occurs. Their nuclei are conspicuous, and around them are numerous chromatophores in all stages of distention by vacuolisation. Their grains of colouring substance are, however, sharply defined and characteristically developed as in the outer rind. Their sap is transparent and non-granular. From both the membrane of the fruit segments and their flesh calcium oxalate and any appreciable accumulation of hesperidin are absent. For the moment it will suffice to state that in such a mature healthy fruit the total solids may average 14% by weight, carbohydrates from 4% to 6%, and alcohol approximately 0.1%. But if accumulation of carbon-dioxide be permitted at temperatures around 18 degrees Centigrade for a period of from ten to thirty days in an enclosed atmosphere the rind becomes pale. If the fruit is then exposed for a few days to a free moist atmosphere or in a chamber with restricted aeration at even moderate temperature the outer rind may become soft, its pitting is lost and the fruit is liable to fungal attack. An analysis of such fruit may reveal a fall in total solids to approximately 12% and of carbohydrates to 1% or 2%. There is, however, a marked increase in alcohol up to 0.5% or 1%. An examination of the tissues reveals a general flooding of the intercellular spaces of the outer rind and of part of the inner rind, a slight increase of calcium oxalate and a marked deposition of hesperidin independent of artificial or induced precipitation. The hesperidin is readily observable as small white specks in the tissue of the rind.

If the fruit which has thus endured conditions of increased atmospheric carbon-dioxide is submitted to still higher concentrations of this gas for a further period of from five to eight days its colour undergoes a remarkable

change. It steadily darkens till at last it is of a dark and dull brown colour. The rind is of a peculiar and not unpleasant odour and is highly elastic. Complete asphyxiation of the fruit has been gradually induced by the treatment to which it has been submitted. The fruit is now remarkably heavy by the accumulation of moisture which its unhealthy body has drawn from its atmosphere. The inner rind is fully flooded and is of a yellow or brown colour. Both the rind and the membranous skin of the fruit segments are extensively marked by white dot-like masses of hesperidin, while an extensive deposition of calcium oxalate has now occurred in the membranes of the fruit segments and even in the vesicles. The latter have lost their brilliant colour; they are no longer transparent but have acquired a slight opalescence due in part to turbidity of their sap. In both the rind and the fruit vesicles extreme vacuolisation of the chromatophores has occurred and commonly the colouring matter is disintegrated or dissipated and shows curious colour reactions, such as the production of a brilliant green when treated with iodine solution. A chemical analysis of such unsound fruit reveals a fall in total solids to approximately 10% and of carbohydrate reserve to less than 1%. The alcoholic content may exceed 2%. The course of degradation here briefly sketched has been shown by prolonged investigation to be referable in initiation as in its later stages to a steady increase in the carbon-dioxide of the external atmosphere, leading first to abnormal respiration, which becomes later obligate for all the living tissues of the fruit. Their normal vital processes are thus arrested, and in the losing struggle against an unfavourable environment complete readjustment of the physiology of the fruit occurs, with wastage of living substance and of the fuel reserve of its body, and a rise in alcoholic content with fermentation. A fundamental transformation of the constituents of the fruit has occurred, while loss of total solids appears to be restrained within moderate limits merely by the reduced vitality of the fruit and the early death of many of its component cells. The ultimate condition of oranges as above described is little known to the fruit trade, mainly because the extreme conditions determining its development are happily seldom attained in practice. But during the past year it has appeared in the port of Liverpool and has aroused considerable interest. It has occurred in a consignment of American oranges transported for approximately 23 days in thermos cases, which are said to serve admirably for the transport of fruit during short railway journeys, inhibiting the growth of fungi and maintaining a cool atmosphere around the fruit itself. It will be apparent that this treatment is useless in practice for sea journeys of any length or for prolonged store, for not only is the fruit killed and its substance degraded but the temperature of the atmosphere of the thermos boxes is steadily raised by the changes of the fruits themselves.

The course of degradation here considered is one of a number to which such fruits are prone under conditions which are known and can be avoided. The conviction has grown from the results obtained from large scale experiments

in Liverpool that the attainment of normal maturity need not entail any real or unavoidable risk in the preservation of fruit during transport by sea or conservation in store, under conditions of controlled atmosphere which are little removed from the normal for the fruit itself. Normal maturity may, indeed, be followed by extended and healthy dormancy which can be maintained both in the holds of ships and in store. Thus for example a considerable quantity of Valencia oranges has been kept in mature health and dormancy from October 1924 until July 1925, while apples of varied grade—including inferior qualities of fruit now considered unsuitable for store—have likewise been kept on a commercial scale from the beginning of October, 1925, to the present date, without the intervention of cold storage or chemical treatment. There is every reason to anticipate that the apples now stored at normal temperatures in Liverpool can be retained in dormancy and health for at least six months. The success so far attained with these fruits is attributed to the fact that normal maturity is little more than the cessation, or virtual cessation, of an orderly series of biochemical changes beyond which prolonged dormancy can be imposed or induced at the expenditure of a minimum of food reserve, without the induction of abnormal physiological states due to such factors as low temperature. A high level of dormant vitality is thus maintained, degradation may be delayed and parasitic diseases avoided. It is essential, however, that for each fruit thus treated the conditions of normal dormant vitality over long periods must be fully known and maintained.

Attention has similarly been given during the past three years to the nature and effects of certain parasitic organisms which are responsible for important losses to vegetable foods during transport by sea. Thus, for example, the fungi mainly responsible for losses to Brazil nuts during transport from the Amazon to the port of Liverpool have been under investigation. It is believed that the conditions now existing in the holds of ships not only favour the spread and activities of these fungi, and cause the rapid degradation of the meat of these nuts, but at the same time will continue to restrict the volume of nuts per hold which can be carried, and must continue to involve considerable avoidable expense, labour, and exposure of the produce itself, during the voyage. To those who have studied the sampling of these nuts after disembarcation the extent of the losses which may be incurred is well known. Here, again, it must be borne in mind that a definite knowledge of the structure and nature of both the nuts and the fungi which attack them is essential to a proper understanding of the means which may restrict or eliminate loss and increase the volume of cargo. The shell is composed of two layers the outer of which is crinkled and covered by a firm skin. The outer layer is composed of a few strata of compact thick-walled cells. Their cavities are reduced to narrow passages containing the remains of living substance. These passages are easily invaded by fungi which obtain therein food for growth. The inner layer is likewise composed of a number of strata. The walls of its innermost

layer are only moderately thick, but are nevertheless hard and contain water and food materials on which fungi may thrive. The shell is three ridged. Under each ridge the tissue of the inner layer tends to disintegrate as the nut ripens. There are thus formed a number of passages in which fungi may grow in the shell. The shell is highly porous. Thus both breathing of the dormant kernel and desiccation of the shell are normally permitted if the nut is fully aired and fungal organisms have not blocked the passages in the shell. Ripening of the nut is further accompanied by drying and commonly by extensive disintegration of the single skin layer. Thus removal of the skin promotes both desiccation of the shell and breathing of the living kernel. If then fungi can pierce the skin while the nut is still immature they will find therein sufficient water and food which can be mobilised for growth. Certain fungi to which these nuts are commonly exposed have been shown to be capable of entering and traversing the shell in 15 days if the latter contains even a low percentage of free water. The need of full maturing and thorough drying of the shell before shipment is thus indicated. But even if this can not be attained in all cases it becomes the more essential that the conditions to be maintained within the strict confines of the holds of ships shall be such that desiccation can be completed at a controlled rate and breathing permitted for the kernel of each nut in strict conformity with the physiology of its normal and healthy dormancy. Thus, and only thus can the safety of the entire cargo be assured during a voyage of some thirty days. The steps of fungal attack in the shell have been fully studied. It is established that even although the kernel may not have been invaded by the fungal hyphae infection of the shell induces abnormal respiration, and later a rapid asphyxiation of the kernel. The tissues of the latter are thus rapidly depleted of their store of oil and become rancid and gummy. At a later stage in invasion the kernel is completely dissipated, so that little remains but a shrivelled mass of decayed matter in which abundant white granules of calcium oxalate crystals predominate. This condition is commonly found in nuts which appear on superficial examination of their shells to be uninfected and is among the commonest of the diseased states in which these nuts appear as dessert at table. A definite realisation of the potential dangers of such decayed conditions has led the American authorities to insist at times on the shelling of these nuts before they are exposed on the retail market. It is, however, believed as the result of extended experiments which I have conducted on a commercial scale that not only can thorough desiccation of the shell be accomplished and healthy breathing of the kernel be maintained in the holds of ships, but that also it is possible to transport a full cargo of such produce for at least forty days under closed hatches without any appreciable loss.

Such instances as are here considered are merely illustrative of the bearing of pure research upon our economic problems. But they provide definite encouragement for the belief that food wastage can be practically eliminated

by simple and inexpensive means which are in strict accord with the biological needs of the foods themselves. The view is held that as with timber, so also with fruit, the day is not far distant when many varieties of important produce now considered untransportable will be made available. The importance of our ports, such as London and Liverpool, must in this connection be now realised and faced, whatever may be the lines of development of research on the problems of fruit and the control of its diseases. Ports are the gateways of the country for carried foods, and in them alone can the problems of food transport under the conditions of ships be properly studied. It is essential that in each of our great ports there should now be established an institution for research on the problems of fruit transport and the control of fruit diseases. The general public cannot be aware of the range of problems involved, but to all who have taken an enlightened scientific interest in this matter and who have—as has the writer—an intimate daily contact with problems of food transport and disease in a great port, the need is so apparent that it is matter for some surprise that it has not yet been met. But the problems which are involved are too great and numerous to be conducted by individual investigators alone. Thus it is impossible for the writer and his students to undertake under present conditions even a small part of the investigation which daily calls for attention in Liverpool alone. A growing personnel of trained investigators and observers, whose work shall be continuously controlled and directed and co-ordinated is similarly required in each of our food ports. They must be enabled to co-operate harmoniously with the port authorities and with the trading and shipping community, encouraging the latter by successful experimentation and by the assistance of knowledge to new exploitation of the world's food reserves, and in particular by the perfecting of means of prevention of disease and waste. My appeal would in particular be directed to those in authority who can avail themselves of the facilities and staffs and students of our Universities and can give them the fullest possible support in the conducting of fundamental research, and opportunities for increased usefulness. There is every cause to believe that by the establishment of research institutions in our ports the nation will quickly benefit and the business community will be healthfully stimulated.

To all who are familiar with the conditions prevailing in America it is, however, obvious that food preservation in store is merely in its infancy in these islands. As far as fruit is concerned it may truly be said that the vast proportion of fruit of American origin which we consume is stored in the United States and Canada, and is merely drawn from store for transport and shipment as required. But it cannot be long till the needs of extended storage in Britain will be realised. The question then arises, what will be our national policy in this matter as successful methods of fruit preservation are extended and its need has been understood? The problems of fruit preservation in store and in ships are fundamentally the same. I would venture to express the belief that the preservation of ripe fruit on large commercial scales is as attainable in

stores as it is in the holds of ships by methods demanding neither the practices of cold storage nor the expenditure which it involves.

DISCUSSION.

SIR EDWARD DAVSON, in opening the discussion, remarked that this country was to a very large extent dependent on its food supplies from abroad, and those food supplies were to a large extent limited by distance; that was to say, by carrying power. If there was no such thing as cold storage we should all probably starve, but there was such a thing as cold storage, and we lived. But no man could say that the cold storage limit was the final limit. He thought it would be agreed, especially after the reading of the paper that evening, that that circle, as he might call it, could be extended very much further afield, and that not only could new fruits be brought in to sustain the population of this country, but that it was also possible that existing fruits (and presumably also meat) could be drawn upon to a very much greater extent than it had been possible to do in the past, if more efficacious methods than those now existing could be found of carrying and storing those fruits and meats. In the case of meat there was a limit of distance to the transport of chilled meat. It was hoped that in the future that distance would be increased by many thousands of miles. There was also a limit of distance to the transport of fruit. Bananas were a case in point. Experts said that bananas could only be carried a 17-day journey. That figure was based on present experience of cold storage. The time would come, he believed, when it would be possible to carry bananas for a 70-days journey, whenever scientific research could be developed to the extent which the lecturer had indicated that it would be developed in the future. As a producer of products in tropical parts of the Empire, he was very much interested in that gleam of hope, if he might so phrase it, that in the future those tropical products might be brought to this country in ever-increasing quantities and in ever better condition, and thus not only increase the wealth of those who lived and worked in the Tropics, but also help to reduce the cost of living to the population in this country.

SIR FORTESCUE FLANNERY, Bt., M.Inst. C.E., thought the thanks of the audience were due to the lecturer for the fresh light which he had thrown upon the problems which faced those whose duty it was to fulfil the conditions of safe carriage for the food supply that was, in ever-increasing quantities, becoming necessary to the people of this country. The question might be divided into two sections. Firstly it was necessary to know the conditions which must be fnlfilled in the carriage of fruit and food, and, secondly, it was the duty of engineers to fulfil those conditions. The improvements which had taken place in the past with reference to the carriage of food had been so vast as justly to found the hope that the necessary further improvements would occur in the future. He could remember when scarcely a ship arrived in this country with a cargo of refrigerated food or fruit without some claim being preferred for damaged cargo. To-day, however, the very reverse was the case. It was quite an exception for any real well-grounded complaint to be made by the owner of the cargo. Ship-owners and their engineers had many difficulties to overcome in fulfilling all the very rigid conditions attaching to the carriage of food, but he ventured to say on behalf of those ship-owners and engineers that lectures like the present, which would disseminate the knowledge of what was required and the problems necessary to be solved, were of the utmost possible value. When those problems were thoroughly known, he ventured to say that

engineers would be capable of overcoming them and of carrying out the necessary requirements with entire success. Let those who had to do with the scientific investigation of the fruit itself, and those who were responsible for its safe carriage, go forward in the full belief that they were doing a national service in that they were helping to raise the standard of national life.

Mr. Hal Williams said the audience had had a peep into the future and into the past, but personally he took a very lively interest in the present. Much as he had enjoyed the lecture, he felt as if he had been at a performance of Maskelyne and Cook's. They had been told that these things could be done, but they had not been told one word as to how they were done, what the process was, or anything about it. Many present were fruit merchants; some were fruit growers; others were scientists and engineers, and he thought it was due to them that the curtain should be lifted a little further.

Sir Frank Baines, C.V.O., C.B.E., thought the last speaker had been a little hard on the lecturer after the brilliant way he had dealt with the problem. Personally he was entirely ignorant of any of the real problems of fruit preservation, but he had a fairly clear idea as to what the lecturer had been trying to convey to his audience. It was that the fruit had to be treated, when it was carried, as a living organism and not as a dead organism, and the mistake of the cold storage expert must not be made of treating it as frozen mutton. It must be remembered that fruit was an organism which gave off carbon-dioxide, that it required a certain amount of fresh air and conditions of humidity, temperature and aeration. Therefore he suggested that the lecturer had given a solution of the problem, namely, that the fruit should be treated as a living organism, and that it should be given, during transit, the conditions which it enjoyed when it was upon the tree. The suggestion was that the whole matter of cold storage had been going in the wrong direction with regard to fruit. He knew there were great differences of opinion in this matter. He had been told by people who dealt with the marketing of fruit that when they had put fruit which had been in cold storage on to the market they had to get rid of it as quickly as possible. He had also been told that the condition of the fruit under cold storage had to be repeatedly examined. If the lecturer could be more explicit it would be to the benefit of all. For instance, he himself wanted to know whether the conditions in connection with the storage of oranges should be the same as in the case of apples and brazil nuts. A little further elucidation of that aspect of the problem would indeed be valuable. He would like to ask if it was possible to lay down a definite schedule of humidity, temperature and aeration for each particular fruit. The whole matter was of vital importance to the nation, because if its solution was a practical one it would overcome the fundamental difficulty in connection with fruit in this country, namely, glut. At certain seasons of the year our markets got flooded with fruit simply because it could not be stored. If the problem could be solved in a way which would allow fruit to be stored even for a few months, it would be of the utmost importance, and the country would then be able to carry out the injunction of "Eat more Fruit."

Mr. Arthur R. T. Woods, M.A.S.R.E. (U.S.A.), M.I.N.A., M.I.M.E., M.I.Mech.E., said he would have liked to hear something more as to the preparation of these perishable articles before they were presented for transport. That was the essence of the whole problem. If the fruit was presented to the carrier in bad condition, it could not be made good by transport, or by subsequent cold storage. Apples

or any other fruit did not generally ripen uniformly, and if therefore a proper selection were not made when packing so as to ensure the fruit being of a more or less homogeneous character before it left the growers' hands, and, further, if it were not transported to the shipping port in vehicles properly prepared by pre-cooling, it was no use blaming the carrier if the fruit did not arrive at its destination in a satisfactory condition. On arrival, too, at the port of shipment the fruit should be immediately either put on board ship, or, if it were removed from the pre-cooled vehicle, it should be put into cold store, and kept at a more or less even temperature until shipment. The carrier by sea would then have better opportunities of delivering the cargo in good condition. The paper dealt with experiments made with and obtained from fruit after its arrival in this country, without any reference to its treatment prior to shipment, which was exactly the point where all the trouble started. If, however, the conditions as just suggested (i.e., for the fruit to be presented in a fit and proper condition) were fulfilled, most of the difficulties experienced up to the present time would be very much the things of the past.

The Chairman, in proposing a vote of thanks to the lecturer, said the problem was an immensely complicated one. They on the Imperial Economic Committee had been working at the problem of the carriage of fruit in the interests of the overseas Dominions as producers, and in the interests of this country as a consumer, and they had come down to the fact very quickly that it was not possible to advance very far at any single point ; all must advance together. A speaker had said that fruit might be brought in a bad condition, or in the wrong condition, to the ship's side. It might go wrong while it was being carried. It might go wrong when it got into the merchant's hands, or into cold storage at this end. It might go wrong in the hands of the retailer. And it was not merely that it might go wrong, but all manner of financial and other problems were involved. It had to be remembered that oranges, for instance, could not be got from a tree until it had been planted for some half dozen years. Therefore the orange grower, either from his own capital or more generally by borrowing on the mortgage of his property, had to sink quite a considerable sum of money before he was in the position to send his first consignment overseas. It was quite probable, human nature being what it was, that the grower did not calculate for a sufficient margin of money for those six years. So the first problem was raised—that of finance—and here one very soon met the difficulty that the fruit could not be insured in the same way as other goods, on account of the uncertainty of the condition in which it would arrive. Hence to a less degree than in the case of other commodities was it possible to finance against documents. A greater certainty as to the condition of the fruit would render insurance a more easy problem, and it would render finance a more easy problem ; and if the financing of the fruit while on the road from the producer to the consumer could be rendered a more easy problem, the difficulty which the actual grower had at the present time of getting his fruit on to the market would be eased. Those were illustrations showing the complexity of the problem. It was not merely that the fruit must be treated as a living passenger and that its life and liability to disease must be considered, but there were the practical problems of engineering and financing. Then there was the practical problem of selling on the scale on which it was desired to sell. A great advance had been made, in his own lifetime, in the matter of carriage. He believed we should see what the Imperial Economic Committee had suggested in its report of last summer, namely, a system of fruit doctors whose function it would be to consider, not merely as researchers but as daily practitioners, the condition of cargoes whether in transit or in store. Live cattle coming across the

ocean were always accompanied by a veterinary surgeon. The lecturer had appealed to the audience to support by all means in its power the endowment of research in the Universities, and especially, in this matter, in the Universities of the great ports. Personally he felt endowment of research was not enough. For one doctor who was able to do research there were hundreds who were capable of performing the ordinary functions of a practitioner. No man could say which student was going to turn out a capable researcher. It was not a question of ability. It was a question of many other things. The whole point, which was put forward by people like those who directed the cold storage station at Cambridge, was the following. They wanted to train a considerable number of men ; from those men there would be some who would become researchers, but unless the trade absorbed the remainder and gave them a career, and gave even to the researchers prizes, they would not attract, amid the competition of many callings, into that particular line the quality and the quantity of brain that was necessary. He suggested that with the many million pounds' worth of valuable cargo which was at stake all the time it would be well worth the while of the trade to face the fact that attending to the health of fruit was in itself a speciality which engineers, ship-owners and financiers were never likely to acquire. The ascertainment of the conditions was not merely a question of research under ideal conditions in a university laboratory. It meant the daily watching of the fruit in the rough and tumble of trade. Therefore, he ventured to seize the present opportunity of speaking to his expert audience and to ask them to read again the report of the Imperial Economic Committee of last summer, and, if they could, help to give effect to the idea which was therein contained, namely, that there should be a new profession with its researchers and its practitioners who would play their part in developing that great complex trade which consisted in carrying living fruit across oceans. If that could be carried out on a considerable scale, there would be no limit to the size of the market that there would be in this country alone. Fruit was not only a luxury and a medicine, but it was also an alternative to a considerable extent to other foods which were now used. We were nearly reaching the limits of the new wheat fields and the new meat fields on the face of the globe. If one thought what it was possible to raise in the way of fruit in the areas now occupied by the great tropical forests, one would see it would be possible to double the population of the world. He did not say that that would be a good thing, but he did say that we in this island, where we could not grow our own food, ought to lay under our tribute such vast areas as the Congo Forest capable of supporting 400 million people—and those 400 million people need not be there, but in more comfortable climates.

A vote of thanks to the lecturer was then put and carried with acclamation.

PROF. THOMPSON, in acknowledging the vote of thanks, said he fully agreed with the views which had been expressed by the Chairman. What was learned from a small laboratory experiment only gave certain indications of the lines on which a larger scale experiment must be carried out. He was acutely conscious of the difficulties of the problem, visiting daily, as he did, the Port of Liverpool and seeing the ebb and flow of trade. He did believe, however, that on the lines he had indicated things were proceeding very hopefully. Quite a number of shipping people in Liverpool were looking forward with great interest and hope to the application of the methods which unfortunately he had not been able to discuss that night.

With regard to the question of application, he had rather felt when he had come there that night that those who were vitally interested in cold storage would feel

very much that he had not offered a solution. Very often, however, if a problem was stated and it was solved at the same time there was a prevalent feeling that "that is that" and that was the end of it; but if a problem was stated in any aspect which added to its complexity and the answer was not given, interest was stimulated. It was in that spirit, rather than in the spirit of an expounder of alternative methods and how they ought to be applied, and how the necessary conditions should be secured that he had attended that evening. With reference to the question put by Sir Frank Baines, the conditions varied with particular fruits. The conditions were quite different for oranges from the conditions required for certain varieties of apples. The conditions were different for American apples which had been sprayed with arsenious oxide during a dry summer from the conditions for apples from which that substance had been washed. The skin conditions were different. That was one of the reasons for saying that the whole matter was merely in its infancy. Finally he thought a new method such as he had dealt with would change the whole economic aspect of food storage. If he had had the opportunity of discussing the matter more fully he could have given the audience many more details.

The meeting then terminated.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 1.. Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Lieut.-Colonel H. W. G. Cole, "The Paris Exhibition of 1925."

Civil Engineers of Ireland, 35, Dawson Street, Dublin. 8 p.m.

Electrical Engineers, Institution of, at the South Wales Institute of Engineers, Cardiff. 6 p.m. Mr. T. Carter, "The Engineer: His due and his duty in Life."

Engineers, Society of, at Burlington House, W. 5.30 p.m. Mr. W. M. Beckett, "Tidal Power on the River Severn — Some Notes and Suggestions on its Utilization."

Farmers' Club, at 12, Great George Street, S.W. 4 p.m. Mr. James Mackintosh, "The Rationing of Cows for Milk Production."

Oil and Colour Chemists' Association, at Burlington House, W. 8 p.m. Joint Meeting with Society of Chemical Industry on "Methods of Grinding."

Société Internationale de Philologie, Sciences et Beaux-Arts, 8, Taviton Street, W.C. 3.30 p.m. Mahomed Azam, "A great Arabian Poet—Abu'l Aala Almaary."

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Transport, Institute of, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. H. D. Dickinson, "State ownership of Waterways."
At the Town Hall, Leeds. 5.30 p.m. Mr. A. Hacking, "Some Financial and Political Aspects of Highway Development."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. The Rev. B. N. Switzer, "Some Biblical Discoveries relative to the Universe and its Origin."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. A. S. Eddington, "The Constitution and Evolution of the Stars." (Lecture III.)
At University College, Gower Street, W.C. 5.15 p.m. Prof. W. H. Lang, F.R.S., "The Morphology of the Vascular Cryptogams." (Lecture I.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. J. H. Morgan, "The Dominions and Foreign Policy." (Lecture II.); 5.30 p.m. Mr. M. H. Krishna, "Indian Archæology and Anthropology." (Lecture VII.); 5.15 p.m. Dr. R. W. Lunt, "The Chemistry of Ionization by Collision." (Lecture V.)
At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture V.); 5.30 p.m. Prof. Gaetano Salvemini, "The Political Evolution of Italy in the Nineteenth Century." (Lecture V.)
At University College, Gower Street, W.C. 4 p.m. Prof. A. V. Hill, "The Physiology of Muscle." (Lecture V.); 5.30 p.m. Prof. Dr. J. B. Collingwood, "The Influence of Water on Vital Processes." (Lecture I.)
At University College Hospital Medical School, Gower Street, W.C. 5 p.m. Dr. R. A. O'Brien "Active and Passive Immunity." (Lecture I.)

TUESDAY, MARCH 2.. Anthropological Institute, 52, Upper Bedford Place, Russell Square, W.C. 8.15 p.m. Mrs. J. B. Montgomery McGovern, "The Head Hunters of Formosa."

Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7. p.m. Mr. A. C. Burgoine, "Electric Ignition Equipment."

Electrical Engineers, Institution of, at 17, Albert Square, Manchester. 7 p.m. Messrs. J. L. Thompson and H. Walmsley, "Notes on the Testing of Static Transformers."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. T. Wright, "Ventilation and Adjustment of Heat Applicable to Ships."

Metals, Institute of, at the Chamber of Commerce, Birmingham. 7. p.m. Dr. L. Aitchison, "Light Alloys."

Oneirological Society, 8, Taviton Street, W.C. 3.30 p.m. Mr. Patrick Braybrooke, "A Consideration of Sleep and Death."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Meeting of Pictorial Group.

Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Mr. Robert Blakoe, "Mental Concentration."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Barcroft, "The Yolk of the Egg."

Royal United Service Institution, Whitehall, S.W. 3.30 p.m. Anniversary Meeting.

University of London, at the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture VII.)
At Bedford College for Women, Regents Park, N.W. 5.15 p.m. Prof. Dr. Caroline Spurgeon, "Jane Austen."
At Middlesex Hospital Medical School, Cleveland Street, W. 5.30 p.m. Dr. Gustave Monod, "The Influence of Murchison and Franz Glenard." (Lecture I.)

Wednesday, March 3..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. E. Lightfoot, "Road Construction."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. R. A. Watson Watt, "The Directional Recording of Atmospherics"; Messrs. R. A. Watson Watt and J. F. Herd, "An Instantaneous Direct Reading Radiogonimeter."

Heating and Ventilating Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7 p.m. Mr. J. Meech, "The Design and Application of Electric Motors relating to Heating and Ventilating Installations."

Public Analysts, Society of, at Burlington House, W. 8 p.m. Messrs. H. Droop Richmond and J. A. Eggleston, "The Analysis of Acetic Anhydride": Mr. A. L. Bacharach, "Notes on the Determination of Moisture, Calcium and Phosphorus in the Bones of Rats"; Messrs. B. S. Evans and S. G. Clarke, "An Accurate Method for the Determination of Mercury in Solution"; Mr. B. S. Evans, "An Apparatus for Continuous Percolation and for Filtration in Neutral Atmospheres."

University of London, at London School of Economics, Aldwych, W.C. 5 p.m. The Hon. Mr. Justice MacKinnon, "Some Aspects of Commercial Law."
At King's College, Strand, W.C. 5.30 p.m. Mr. Ramsay Muir, "Mr. W. E. Gladstone."
At University College, Gower Street, W.C. 5.15 p.m. Prof. W. H. Lang, "The Morphology of the Vascular Cryptogams." (Lecture II.); 5.30 p.m. Prof. A. S. Peake, "The Servant of Yahweh." (Lecture II.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. Knut Liestol, "Modern Saga and the Reliability of Oral Tradition." (Lecture I.)
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. Ernst Herzfeld, "Persian Archæology." (Lecture II.)
At Middlesex Hospital Medical School, Cleveland Street, W. 5.30 p.m. Dr. Gustave Monod, "Hepatism and Metabolic Disorders." (Lecture II.)
At the Imperial College of Science and Technology South Kensington, S.W. 5.30 p.m. Prof. A. Sommerfeld, "Atomistic Physics." (Lecture I.)

Thursday, March 4..Aeronautical Society, 7, Albemarle Street, W. 6.30 p.m. Major G. H. Scott, "The Development of Airship Mooring and Handling."

Child-Study Society, at 90, Buckingham Palace Road, S.W. 6 p.m. Discussion on "The Curriculum for Children 11-14 years."

Chemical Society, Burlington House, W. 8 p.m. Messrs. S. Sugden and M. Williams, "An Experimental Study of Protective Colloids. (Part I.) The Influence of Concentration."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. R. B. Matthews, "Electro-Farming; or the Application of Electricity to Agriculture."

Linnean Society, Burlington House, W. 5 p.m.
L.C.C., Geffrye Museum, Kingsland Road, E. 7.30 p.m Mr. Ingleson C. Goodison, "Late 17th Century Cabinet-makers and their Work."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. C. D. Ellis, "The Atom of Light and the Atom of Electricity." (Lecture II.)

Royal Society, Burlington House, W. 4.30 p.m.
Structural Engineers, Institution of, at Denison House, 296, Vauxhall Bridge Road, S.W. 7.30 p.m. Mr. S. Bylander, "Steelwork Specifications."

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Prof. W. R. Lethaby, "William Morris as Artist."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Signor A. M. Bassani "Vittorio Alfieri: uomo e poeta."
At King's College, Strand, W.C. 5.30 p.m. Dr. Henry Thomas, "The Romances of Chivalry in the Peninsula."
At King's College, Strand, W.C. 5.30 p.m. Mr. C. J. Gadd, "The Science of Divination."
At the London School of Economics, Aldwych, W.C. 5.30 p.m. Dr. H. W. Meikle, "The Seventeenth Century."
At King's College, Strand, W.C. 5.30 p.m. Vice-Admiral H. W. Richmond, "Sea Warfare."
At the London School of Economics, Aldwych, W.C. 5 p.m. Prof. H. Kontorowicz, "The German Constitution." (Lecture I.)
At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Customary Law in Europe." (Lecture VI.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk-Mirsky, "Early Russian Literature." (Lecture VIII).; 4 p.m. Mr. I. L. Evans, "Economic Development of South Eastern Europe." (Lecture V.)
At King's College, Strand, W.C. 5 p.m. Dr. J. A. Hewitt, "Metabolism of Carbohydrate and Fat." (Lecture VII.)
At Middlesex Hospital Medical School, Cleveland Street, W. 5.30 p.m. Dr. Gustave Monod, "Chronic Nephritis." (Lecture III.)

Friday, March 5..Geologists' Association. 7.30 p.m. Mr. Arthur L. Leach, "The Dolmen Region of South Western Brittany."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. J. M. Seddon, "Modern Tendencies in the Distribution and Utilization of Electric Power."

Philological Society, at University College, Gower Street, W.C. 5 p.m. Special Meeting on Tones.

Société Internationale de Philologie, Sciences et Beaux-Arts, 8, Taviton Street, W.C. 8.15 p.m. Mahomed Abdul-Haleem Bey, "The Design of a Saracenic House."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir Henry Maybury, "London Traffic."

University of London, at University College, Gower Street, W.C. 5.15 p.m. Prof. W. H. Lang, "The Morphology of the Vascular Cryptogams." (Lecture III.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Making of Modern Roumania." (Lecture V.)
At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. Graham Wallas, "Social Leadership." (Lecture IV.)
At University College Hospital Medical School, Gower Street, W.C. 5 p.m. Dr. R. A. O'Brien, "Active and Passive Immunity—Application to Diphtheria." (Lecture II.)

Saturday, March 6..L.C.C., Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "The Other World of the Ancient Egyptians."

Royal Institution, at 21, Albemarle Street, W. 3 p.m. Sir E. Rutherford, "The Rare Gases of the Atmosphere."

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CONTENTS:

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3824 VOL. LXXIV.

FRIDAY, MARCH 5th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 10th, at 8 p.m. (Ordinary Meeting.) REINHARDT THIESSEN, Ph.D., of the Bureau of Mines, U.S. Department of Commerce, "The Micro-Structure of Coal." SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, will preside.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 24th, 1926. LEONARD ERSKINE HILL, M.B., F.R.S., in the Chair.

The following candidates were proposed for election as Fellows of the Society :—

Leutz, Charles Ronald, Long Island, New York, U.S.A.
Pai, K. Rama, Calcutta, India.
Phillips, Henry Lawrence, Bombay, India.
Templeton, Walter Breakenridge, Chicago, Illinois, U.S.A.

The following candidates were duly elected Fellows of the Society :—

Allen, Francis J., Seven Kings, Essex.
Arnold, John Falk, B.Sc., Staines, Middlesex.
Cooper, Henry James, Lieut. R.A.S.C., London.
Desai, Maganbhai Vaghjibhai, London.
Hussain, Khateeb Mahmood, M.A., Hyderabad, Deccan, India.
James, Sidney Hamilton, A.M.I.Mech.E., Rangoon, Burma.
Milne-Smith, Arthur James, Sevenoaks, Kent.
Oka, Masakazu, Tokyo, Japan.

A paper on "Domestic Heating" was read by MARGARET FISHENDEN, D.Sc., F.Inst.P., of the Fuel Research Division, Department of Scientific and Industrial Research.

The paper and discussion will be published in the *Journal*, dated April 2nd,

CANTOR LECTURE.

MONDAY, MARCH 1st, 1926. G. W. C. KAYE, O.B.E., M.A., D.Sc., Superintendent, Physics Department, National Physical Laboratory, delivered the third of his course of three lectures on "The Production and Measurement of High Vacua."

On the motion of the Chairman, Commander Rollo Appleyard, a vote of thanks was accorded to Dr. Kaye for his interesting course, and to Mr. W. H. Sewell, who had prepared the experiments.

The lectures will be published in the *Journal* during the Summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1926, early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 20th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

1864, Sir Rowland Hill, K.C.B., F.R.S.

1865, His Imperial Majesty Napoleon III.

1866, Michael Faraday, D.C.L., F.R.S.

1867, Sir W. Fothergill Cooke and Sir Charles Wheatstone, F.R.S.

1868, Sir Joseph Whitworth, LL.D., F.R.S.

1869, Baron Justus von Liebig.

1870, Vicomte Ferdinand de Lesseps, Hon. G.C.S.I.

1871, Sir Henry Cole, K.C.B.

1872, Sir Henry Bessemer, F.R.S.

1873, Michel Eugène Chevreul, For. Memb. R.S.

1874, Sir C. W. Siemens, D.C.L., F.R.S.

1875, Michel Chevalier.

1876, Sir George B. Airy, K.C.B., F.R.S.

1877, Jean Baptiste Dumas, For. Memb. R.S.

1878. Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

1879, Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

1880, James Prescott Joule, LL.D., D.C.L., F.R.S.

1881, Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.

1882, Louis Pasteur.

1883, Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

1884, Captain James Buchanan Eads.

1885, Sir Henry Doulton.

1886, Samuel Cunliffe Lister (afterwards Lord Masham).

1887, HER MAJESTY QUEEN VICTORIA.

1888, Professor Hermann Louis Helmholtz.

1889, John Percy, LL.D., F.R.S.

1890. Sir William Henry Perkin, F.R.S.

1891, Sir Frederick Abel, Bt., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

1892, Thomas Alva Edison.

1893, Sir John Bennet Lawes, Bt., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

1894, Sir Joseph (afterwards Lord) Lister, F.R.S.

1895, Sir Isaac Lowthian Bell, Bt., F.R.S.

1896, Professor David Edward Hughes, F.R.S.

1897, George James Symons, F.R.S.

1898, Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

1899, Sir William Crookes, O.M., F.R.S.

1900, Henry Wilde, F.R.S.

1901, HIS MAJESTY KING EDWARD VII.

1902, Professor Alexander Graham Bell.

1903, Sir Charles Augustus Hartley, K.C.M.G.

1904, Walter Crane.

1905, Lord Rayleigh, O.M. D.C.L., Sc.D. F.R.S.

1906, Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.

1907. The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.

1908, Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.

1909. Sir Andrew Nobel, K.C.B., D.Sc., D.C.L., F.R.S.

1910, Madame Curie.

1911, The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., F.R.S.

1912, The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., D.C.L., F.R.S.

1913, His Majesty King George V.

1914, Chevalier Guglielmo Marconi, G.C.V.O., LL.D., D.Sc.

1915, Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S.

1916, Professor Elias Metchnikoff

1917, Orville Wright.

1918, Sir Richard Tetley Glazebrook, C.B., Sc.D., F.R.S.

1919, Sir Oliver Joseph Lodge, D.Sc., LL.D., F.R.S.

1920, Professor Albert Abraham Michelson, For. Memb. R.S.

1921, Professor John Ambrose Fleming, D.Sc., F.R.S.

1922, Sir Dugald Clerk, K.B.E., D.Sc., LL.D., F.R.S.

1923. Major-General Sir David Bruce, K.C.B., D.Sc., LL.D., F.R.C.P., F.R.S., and Colonel Sir Ronald Ross, K.C.B., K.C.M.G., D.Sc., LL.D., M.D., F.R.C.S., F.R.S.

1924, H.R.H. The Prince of Wales, K.G.

1925, Lieut.-Colonel Sir David Prain, C.M.G., C.I.E., M.B., LL.D., F.R.S.

PROCEEDINGS OF THE SOCIETY.

EIGHTH ORDINARY MEETING.

Wednesday, February 3rd, 1926.

The Right Hon. Lord Clinton, Chairman, Lawes Agricultural Trust, in the Chair.

The Chairman said that in the first instance he wished to say how much he appreciated the courtesy of the Society in asking him to take the chair on that occasion, when members were to hear from Sir John Russell something of the investigations in agricultural science which were being made at Rothamsted. It was a matter of first-class interest not only to all who were connected with the agricultural industry, whether from the scientific or from the practical point of view, but to those who were concerned with the national point of view. It was certainly at present a matter of national importance, and he did not think anyone was better qualified than Sir John Russell to discuss the matter before any audience. Probably many of those present were aware that Rothamsted was not only the oldest, but by far the most important experimental station for agriculture in the whole world. It was founded in the year 1843 by Sir John Bennet Lawes, who for sixty years carried on the whole of the work at his own expense. He was not only a man considerably in advance of his times, but he was a very enlightened and a very progressive agriculturalist and investigator, and many monuments to his great achievements could to-day be found in the everyday, practical working of the farm. Sir John Bennet Lawes, who died in 1900, was

succeeded by Sir Daniel Hall, whose absence he very much regretted that evening. Under his very able direction the work of the experimental station had been very considerably developed and enlarged. He, in his turn, being called to office in the Ministry of Agriculture, was succeeded by the present Director, Sir John Russell, and under his exceptionally able guidance there had been not only a very great progress in the actual work of investigation, but through his own efforts, and through the efforts of the very enthusiastic staff which he had gathered around him, he had created a really remarkable feeling of confidence on the part of that large and increasing body of farmers who were now realising the importance of scientific research in agriculture.

The following paper was then read:—

INVESTIGATIONS IN AGRICULTURAL SCIENCE AT ROTHAMSTED.

By Sir Edward John Russell, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station.

The Rothamsted experiments began and grew up in typically British fashion. They were started by John Bennet Lawes 83 years ago on his own land and at his own cost for the purpose of showing him how plants grow. They were planned so well and made so thoroughly that they yielded much wider information than was expected. The information was freely given to farmers who, in return, in the year 1855—long before the days of agricultural education—sub-

Fig. 1. The first scientific laboratory built by farmers. Rothamsted Laboratory, 1855—1914.

scribed to build a laboratory in which the necessary scientific work could be done. This was the first scientific laboratory to be built by public subscription. (Fig. 1.) To the end of the century Lawes and his colleague Gilbert worked together, the longest scientific partnership in history, always at the sole expense of Lawes —in conformity with the ideas of private enterprise and self-help held by the great Victorians: repeating the same field experiments year after year because they continued to give fresh information. Finally, before his death, Lawes set up a Trust which he endowed with £100,000 to carry on the work in perpetuity. Lawes and Gilbert have been dead for more than 25 years, but the work still continues without change of tradition, purpose or policy: the changes in the Trust Committee have been few and infrequent; indeed, one of the original members, Professor H. E. Armstrong, is still with us; there have been in the whole 83 years only two directors before my appointment.

No other agricultural experiment station in the world has so long a history possessing so many unique features. The unchanging tradition of the place is that all the work shall be of the highest attainable standard: that the smallest decimal point shall be as trustworthy as it can be made. The long experience of the station shows that trustworthy work is always valuable; we are repeatedly, even to-day, using figures obtained 60 or 70 years ago and still finding them helpful. The purpose of the work has always been to obtain knowledge: knowledge of plants and soils, rather than to show farmers how to obtain more money. This too is justified by events, for the knowledge is permanent and helps the farmer in all conditions, while the practical advice must change continuously from farm to farm and from year to year. Finally, the policy has always been to put the information obtained in such form that students, teachers, experts and leading agriculturists could use it as a foundation on which to build up the particular recommendations to be made to farmers to meet the particular conditions of the time.

All this remains, and let us hope always will remain, unchanged. But the work has altered and expanded enormously; it is carried on by a staff of 40 vigorous able scientific workers and an equal number of competent assistants; the laboratories have been entirely rebuilt in recent years on a much enlarged scale. The station has far outstripped its original resources, and now, in accordance with the spirit of the age, it receives substantial state aid through the Development Fund and Research Funds, administered by the enlightened and sympathetic staffs of the Development Commission and the Ministry of Agriculture. The attitude of the farmers is as sympathetic as ever, and the chief agricultural bodies, the Royal Agricultural Society, the National Farmers' Union, the Central Landowners' Association, the Central Chamber of Agriculture, the Farmers' Club, Workers' Unions, and other organisations all recognise the imperative necessity for scientific research as the basis of agricultural education.

The first achievement of Rothamsted was the discovery that certain simple salts already known or thought to be plant foods could be used on the farm to increase farm crops. Before that time farmyard manure had been the recognised manure; it is of course highly efficient, but can never be obtained in large quantities; the output of human food from the farm was limited by the supplies of farmyard manure. After the discovery of artificial fertilisers the yields rose; wheat increased from 20 to 30 bushels per acre. Wages were low and prices high; crop production was profitable. Then came the great changes of 40 years ago, when transport developed and the exploitation of the vast virgin regions of the world began. Food was poured into this country at prices with which our farmers could not compete; the idea of safe-guarding or sheltering the industry was not entertained, and agriculture suffered terribly. There emerged, by the cruel process of elimination, the result that the farmer should produce only those things for which his land was well suited and for which his markets were good; farming, in short, became a study in adaptation; finding out what crops would grow best, eliminating those that would not grow well and concentrating on those that would. The adaptation is never perfect in Nature; something has to be done to the soil to make it suit the plant, and something to the plant also to make it a little more suitable to the soil. The better the plant fits the soil the better is the chance of success, and the aim of the scientific agriculturist is to get a perfect fit.

The Rothamsted workers study the methods of altering the soil and of effecting minor changes, fine adjustments, so to speak, in the plant; the first business of producing a range of plants suited to different soils and climatic conditions being done by plant breeders elsewhere.

One of the simplest means of improving the soil for the growth of crops is to add manures, farmyard manure or a mixture of artificial manures. The manured plant is larger than the unmanured, and so the yield increases. But it is not a photographic enlargement; there is always some distortion. Nitrogen compounds enlarge the leaves and stems more than the roots; phosphates enlarge the roots more than the leaves. This is shown in Fig. 2, where an unmanured swede is compared with others manured respectively with phosphate and nitrogen *plus* phosphate. The relative weights of the plants when the unmanured is put at 100 are:—

	No Manure.	Super-phosphate	No Nitrogen.	Super. + nitrogen compounds.
Leaves	100	183	100	191
Roots	100	324	100	150

All crops are of course dependent on their leaves, and most crops, with the general exception of the leguminosae, to which I shall refer later, respond to

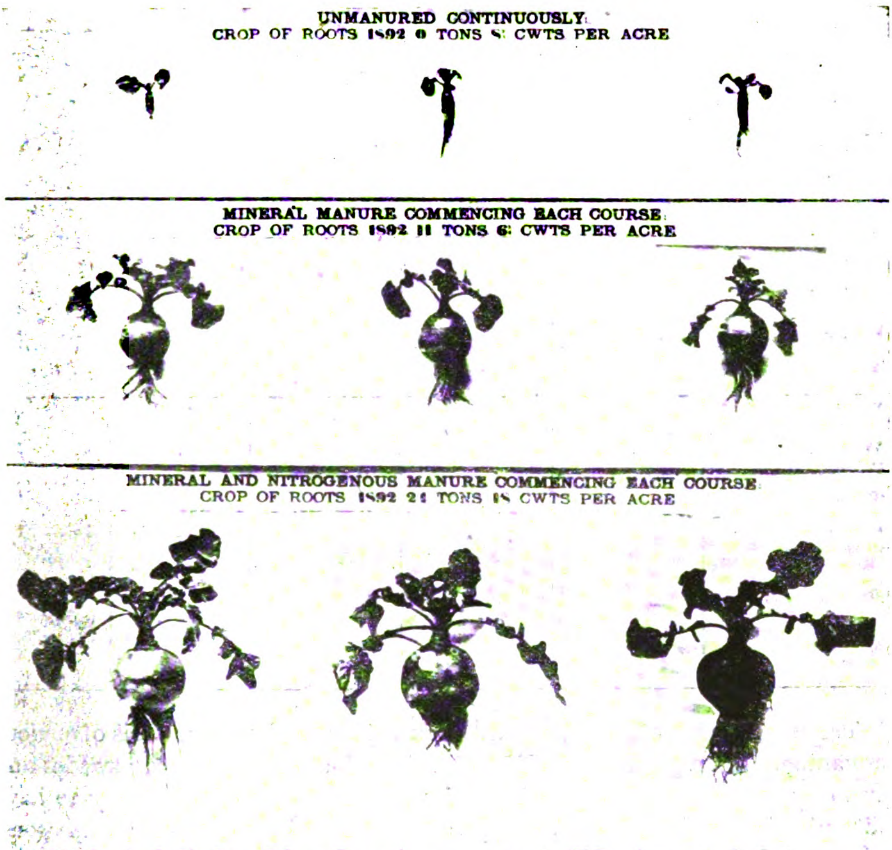

FIG. 2. Lawes and Gilbert's experiments with swedes. Upper row, no manure; middle row, mineral manure, including superphosphate; bottom row, nitrogenous manure in addition.

nitrogenous manure. But for some crops abundant leaf growth is especially important, therefore they always receive nitrogenous fertilisers, e.g., crops grown entirely for their leaves: including fodder crops such as cabbage, kale, hay, green rye, etc.; or crops which, though not used for their leaves, make heavy demands on them, e.g., potatoes and mangolds.

The Rothamsted experiments have brought out the interesting fact that there is curiously little variation in the effect of nitrogenous fertilisers from year to year. The average increases from the use of sulphate of ammonia are given in Table I; results of the same order, for some crops larger, could no doubt be obtained by nitrate of soda or nitrate of lime in equivalent amounts. Within limits it does not much matter whether one starts from a low or from a relatively high level; the action has thus something of an "additive" nature. About 40 or 50 per cent. of the nitrogen is utilised and the rest on present

methods is lost. This loss of nitrogen is one of the serious problems still before the investigator. The effect of a second cwt. of sulphate of ammonia is sometimes equal to, sometimes less, and sometimes greater than the first, but the effect of a third cwt. is less though it may still be profitable; the Law of Diminishing Returns, has, however, set in.

TABLE I.—*Increased crop yields obtained by the use of 1 cwt. sulphate of ammonia per acre.*

	1922 Rothamsted.	1923 Rothamsted.	1924 Rothamsted.	Outside Centres.	Average of all Soils and Seasons to 1920
Wheat, bu. ..	3·25			4·3—6	4·5
Barley, bu. ..	5·5	4·5	8.16	3·5	6·5
Oats, bu. ..		8·3			7
Potatoes, cwt.	20	22—25	20		20
Swedes, cwt. ..	20	25	5—9	30	20 N. Country 10 S. Country

The special effect of phosphates in encouraging root development is of obvious advantage for crops grown mainly or entirely for their roots, e.g., swedes and turnips; but it also has an advantage whenever the roots are likely to have difficulty in growing, e.g., on heavy soils, in cold districts, backward seasons, conditions where spring droughts are common, which will dry up the plant unless its roots have already struck sufficiently deeply into the soil.

Along with the stimulation of root development there is also a stimulation of tillering and a general acceleration of plant development continuing right up to maturation—whether this is one action or several is not known. The effect is so marked that in high lying arable districts, such as the Wolds, superphosphate is often given to cereal crops expressly for the purpose of hastening the ripening and bringing in the harvest some days earlier than otherwise. The effect can also be utilised to help the plant avoid certain pests. The gout fly of barley (*Chlorops taeniopus*) lays its eggs early in the season at the tip of the leaf. The larvae hatch out and crawl downwards; if the young seed head is still in its ensheathing leaves the larvae enter and feed upon it. But if the seed head has been stimulated to push out even a few days earlier it is safe, because the larvae only crawl downwards and never up the stem. (Fig. 3.)

The special effect of potassic fertilisers is to enhance the health and vigour of the plant which is specially important where growth is being artificially

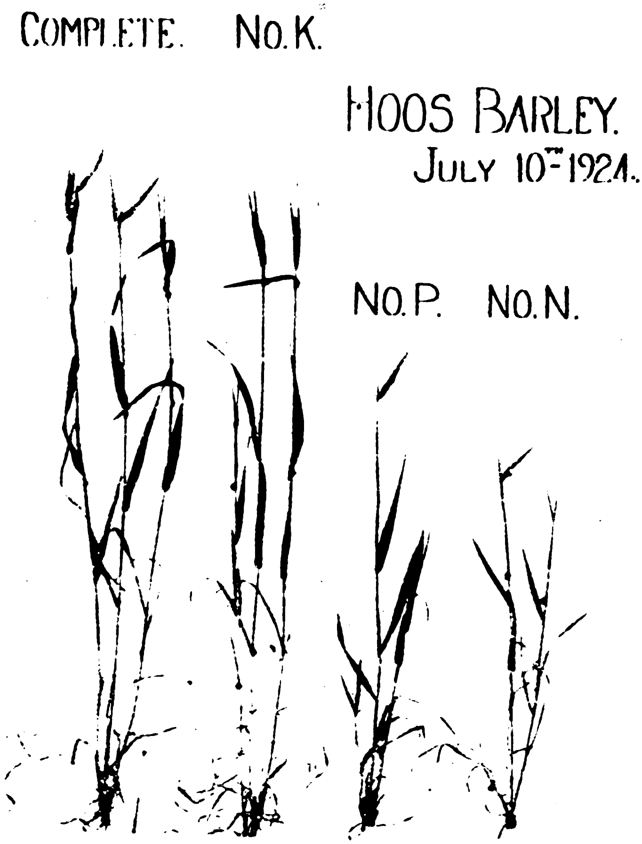

FIG. 3. Effect of fertilisers on the development of the barley plant. Without phosphate, tillering and maturation are both delayed.

stimulated. Any lack of potassium is followed by loss of vigour or disease, whether one is dealing with tomatoes, fruit trees or farm crops, grass, mangolds, potatoes. Mangolds grown without manure are small but healthy. Addition of nitrogenous and phosphatic manures without potassium increases the crop, but at the cost of its health, and when large quantities are given the crop becomes unhealthy and inefficient as a sugar producer. But addition of potassic fertiliser at once restores health and efficiency and leads to a great increase in sugar production. Potatoes behave in like manner, and the facts here are of such great technical importance that they have been worked out in considerable detail so as to help the farmer in his choice of the various potassic fertilisers obtainable: the percentage of starch in the potato and the amount of starch produced per acre are both increased by potassium. (Fig. 4.)

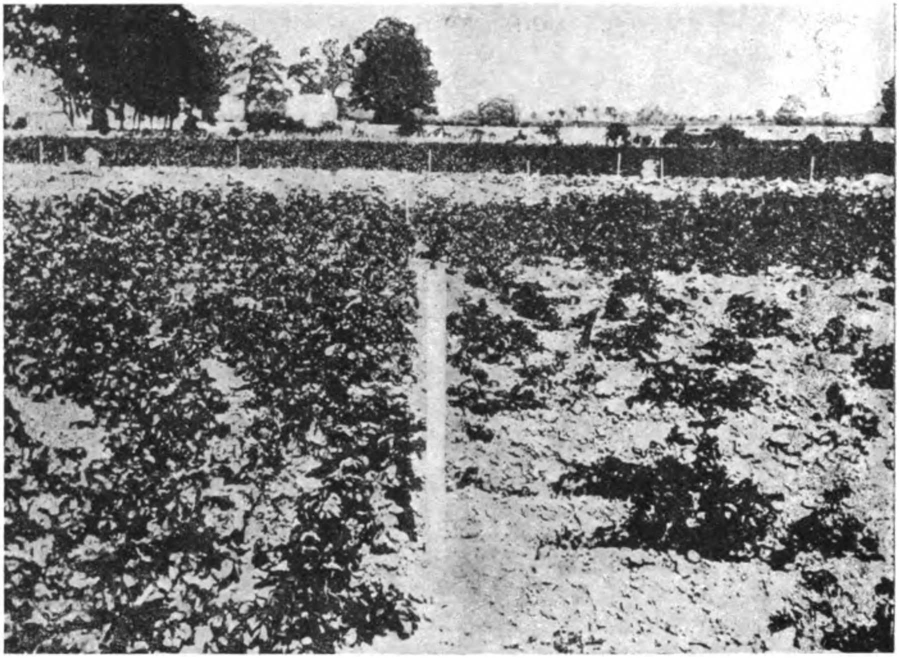

FIG. 4. Effect of potassic fertilisers in increasing yield and vigour of the potato crop. Left-hand plot, supplied with potash; right-hand plot, no potash.

These effects of the fertilisers are modified by other conditions, for the plant is very plastic and easily altered by soil factors and by weather. A scheme good in one season may be useless in another and, until the effect of soil and weather on fertiliser action is known, it is impossible to give definite advice to farmers. Special methods are required for this investigation, because one cannot produce an experimental season; you have to accept what comes and then deduce the actions from the results. It is the supreme advantage of the the Rothamsted field experiments that they have gone on so long. During their 70 or 80 years the rainfall has been measured throughout, and temperature, sunshine and other factors for a considerable time. The relationship of the seasonal factors to plant growth and fertiliser action is studied by modern statistical methods. The effects are of two kinds. Some are produced before the seed is sown; others appear only after the plant is up, but their intensity differs with the method of treatment. These points are illustrated by the curves showing the effects of varying rainfall on the yield of wheat. (Fig. 5.) The effect of rainfall is considerably modified by the method of manuring, and there is reason to hope that schemes of manuring could be worked out suitable for given rainfall conditions.

The introduction of statistical methods for studying the field data constitutes one of the new developments at Rothamsted which we believe will have far-

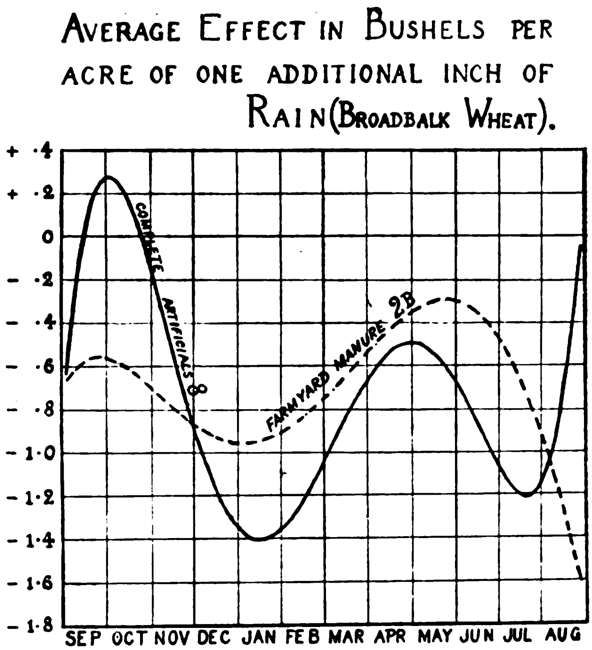

FIG. 5. Influence of rainfall on the yield of wheat. After October the effect is depressing, but it varies with the month and manuring.

reaching consequences. For it not only ensures that the field data shall be thoroughly explored to extract as much information as they will yield. Statistical methods also enable the experimenter to improve his experiments and make his results more trustworthy ; they even go further and enable him to calculate the probable value of his data. The old field plots which gave the first information about artificial fertilisers are not very accurate ; they cannot measure differences of less than 10 or 15 per cent, nor can their trustworthiness be readily calculated. In the first development of a subject when nothing is known, rough methods are often very useful. But as knowledge grows these methods become unsuitable, the scientific workers and the farmer both need greater accuracy than 10 or 15 per cent., the farmer because his margins of profit are cut very finely.

The modern methods of field experiment worked out at Rothamsted are capable of revealing differences of the order of 2 per cent. Some of the potato experiments are shown in Fig. 7 ; these contrast with the older method shewn in Fig. 6.

These general principles hold for all farm crops with the important exception of the leguminous crops. Instead of starving when they receive no nitrogen they flourish quite well. This was a great perplexity to Lawes and Gilbert,

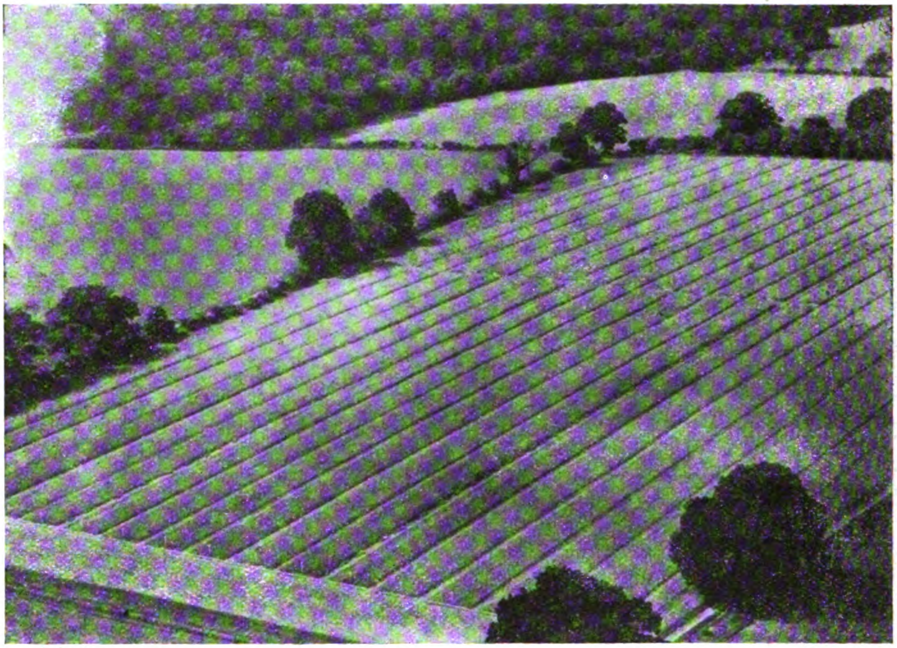

FIG. 6. Broadbalk wheat field. The old method of laying out an experiment; single plots, not duplicated.

who exhausted the resources of agricultural chemistry in trying to explain it; they failed for the reason that has stopped the progress of many other practical problems; because science was not far enough advanced. The answer came when the science of bacteriology developed and showed that leguminous plants do not live by themselves, but in partnership with bacteria in nodules on their roots, and the secret of the successful growth of leguminous crops lies in the successful working of the partnership between the crop and the bacteria.

The early workers isolated the bacteria from the plant and grew them in quantity, with the idea of adding them to the soil or the seed in readiness for the young plant. The idea was sound and the operation sometimes worked admirably, especially in laboratory tests, but it had a disconcerting habit of breaking down, and so the practical man in England would have none of it. It was more successful in Scandinavia.

Investigations at Rothamsted showed that the British failures arose from three or four causes: (1) something might be lacking which the plant needed, and then, of course, no addition of micro-organisms would help matters; (2) some of the soils were acid, on these neither organisms nor plants flourish; (3) sometimes the organisms died on the way to the farm. These various defects were put right, and a discovery was then made which added considerably to the success of the operation. The organism passes through a life cycle in

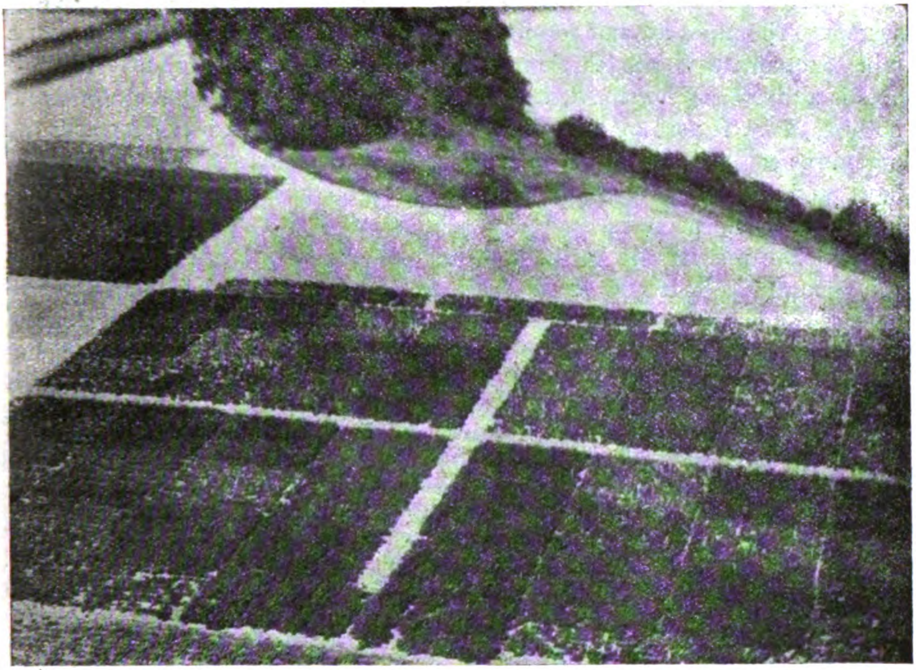

FIG. 7. Modern field experiments; potatoes. Plots laid out in a Latin square, fully replicated.

the soil; in some of the stages it can move about, in others it cannot. The rate of movement is not more than 1 inch in 24 hours, but this is quite enough to make the difference between success and failure. Inoculation succeeds only when the organisms can travel to the young roots. The bacteriologcal workers found that phosphates and a little milk make the organisms mobiile, and so these were introduced into the process. It is now much more effective and is giving good results.

The partnership between the organism and the plant is mutually advantageous. The organism fixes gaseous nitrogen and changes it into a complex nitrogen compound—a change no chemist can effect or even understand—then passes this compound on to the plant. In return the plant supplies the organism with sugar, the great motive power in the reaction; the fixation of nitrogen, however it is done, requiring considerable energy which has to be obtained by the oxidation of something. Directly the organism gets into the root the plant sends out a network of conducting vessels from its main circulatory system to surround the colony of organisms, carrying sugar to them and drawing off the nitrogen compounds. These vessels are, therefore, the conduit pipes connecting the organisms and the plant and making the partnership effective.

A remarkable discovery was made at Rothamsted about this connecting system. The pipes are not formed unless a trace of boron is present; only a minute quantity is needed, larger quantities injuring the plant. How it acts is a mystery; no substitute is tolerated, the plant will have boron and nothing else. If boron is not given the conducting system is not formed, the organisms can neither obtain sugar nor give up the nitrogen compounds they have produced; they therefore feed on the root and become harmful parasites instead of useful partners.

This close relationship between plants and organisms turns up repeatedly in agriculture. It is now known that the process of making plant food in natural soil is brought about by micro-organisms which feed upon dead plant residues and break them down into the simple foods of plants. They are being closely studied at Rothamsted; time does not allow an adequate discussion of the results, but there are two other directions in which a practical application is being sought.

It has always been known that farmyard manure is a highly effective fertiliser. It was for a time rather neglected by agricultural chemists, who were dazzled by the striking effects produced by artificial fertilisers in the flush of the first great triumph for agricultural chemistry. But experience has shown that artificial fertilisers are insufficient in themselves to maintain fertility permanently; farmyard manure or other material of like nature, i.e., bulky plant residues, is needed. For farmyard manure not only provides a complete food for plants—the only complete food at present known—but it also improves the soil. But farmyard manure is not in itself the food of plants; it becomes plant food only after it has been broken down in the soil. Now this breaking down is done by micro-organisms, and the question arises whether micro-organisms could not do the whole process of making farmyard manure from straw as well as decomposing it in the soil. Experiment showed that they can; if the organisms are given enough water and nitrogenous food and are not injured by acidity, they make a very useful manure out of straw or other vegetable refuse which otherwise would have but little value. The method is being applied on the large scale by the Adco syndicate, a non-profit-making body financed by the public spirited action of Lord Elveden.

A third application of the knowledge of micro-organisms is made at present chiefly in glass houses. The population of a glass house soil is very mixed and not all helpful to the plant. On the whole the harmful organisms are more easily killed than the beneficial ones, and so a process of heating or poisoning the soil has the paradoxical effect of improving its fertility. Certain benzene derivatives are very promising. The work is being developed at Rothamsted in the laboratory for the study of insecticides, because it is found that certain closely allied substances are effective insecticides, and there seems to be foreshadowed the possibility of a new industry in making substances to control soil organisms and insect pests.

So far we have devoted our attention entirely to the feeding of the crop. There remains the more difficult problem of the cultivation of the soil. Long generations of farmers have evolved a highly efficient art of cultivation, while generations of village smiths, and afterwards their successors the engineers, have developed tools and implements for doing the work. But the whole thing is empirical; there is as yet no scientific basis for either farmer or engineer to work on; and in consequence there is the risk that the work is not being done as well or as cheaply as it might.

Cultivation is simply moving the soil, but the result is to collect the fine particles into crumbs, and this not only brings the soil into good condition for root development, but improves the moisture and air relationships of the soil.

The mechanical part of the process—the moving of the soil—involves three distinct actions: cutting the soil; sliding the tool over or through the soil; and lifting the soil to turn it over. The processes are all capable of physical investigation. The first step is to measure the total action by a dynamometer recording the draw bar pull between the tractor and the implement. The measurements are complicated by the fact that the soil even in one and the same field is variable, some parts of the field being much more resistant than others. Statistical examination of the data is therefore always necessary. The amount of the pull depends on the constitution of the soil; partly on the visible mineral particles, but mainly on the minutest particles, the clay, which have marked colloidal properties. Colloids are much modified by electrolytes and by other colloids; a striking example is seen in the reduction in draw bar pull brought about by the addition of lime and colloidal organic matter, i.e., decayed farmyard manure or plant residues.

Extended analyses of the dynamometer records and of the physical properties of the soil are necessary before it is possible to disentangle the parts played by friction, cohesion, plasticity and mechanical work, but the task is capable of precise execution. The further step of discovering how the soil crumbs are formed and how and why their formation should improve the moisture and air relationships of the soil, necessitates studies of surface forces and colloidal properties, which, while lengthy, are within the ambit of a well-equipped physical department.

One of the firstfruits of the physical investigation has been the discovery of a simple means whereby the resistance of the soil to the plough could be reduced. The soil colloids are electronegative; if therefore a negatively charged plate is inserted in the soil the water will pass out from the colloid and become deposited on the plate. Now a film of water is an almost perfect lubricant; if, therefore, the ploughshare is kept negatively charged, it becomes coated with a film of water, and therefore continuously lubricated, so that it moves through the soil with less resistance than before. The maintenance of an electric charge is not in principle difficult: it necessitates taking current from the tractor drawing the plough.

The farmer is not dealing with soil alone, but with soil plus water: the soil remains the same but the water varies considerably from week to week according to the rainfall. All these properties therefore have to be studied in reference to the quantity of water present in the soil.

The cutting through the soil—in other words its cohesion—becomes less and less as the water increases; if this were the only factor in cultivation the wetter the soil the better; but the friction on the other hand becomes greater and greater as the water increases; if this were the only factor concerned the drier the soil the better. For each soil there is a certain range of moisture content when cultivation is most easy, neither cohesion nor friction being too great. Further, over this range, variations in moisture content, while they greatly alter the cohesion and the friction, do not appreciably alter the labour of cultivation, the loss on one property being made up by gains on another.

The end result is not new: good ploughmen know it already and have practised it for generations; they have learnt by long experience the happy mean content of water within which the soil can be cultivated and they do not attempt cultivation when the soil is too dry or too wet. But the analysis and explanation of the facts could not before be given.

This experience happens over and over again whenever an art is being reduced to a science. Harrowing the soil gives a further illustration. Its object is to break the soil lumps to pieces and get them finally down to grains. The scientific worker shows that as a lump of soil dries it shrinks, first by the exact volume of the water lost, afterwards by less than this volume. When the dried soil is rewetted it expands, but it expands more than it shrank. The phenomenon is common among colloids and is called hysteresis; it admits of a simple explanation, because the original wet lump contained no air in its inner-most crevices, while the dry soil does contain air; on rewetting, the original air is still imprisoned and helps to expand the lump of soil. It follows that a soil containing a given amount of moisture may occur in two states: the down grade or the up grade, and in the up grade it is expanding more with increasing moisture than in the down grade because of the imprisoned air, and it is therefore more unstable and easily shattered. In order to get the best effect from harrowing, the farmer should allow the soil to dry beyond the point where harrowing would be effective, and should then wait for the rain to rewet the soil up to this point before he harrows. The facts are clearly ascertained and the deduction perfectly sound and of great practical value. But once again the art of the practical man has forestalled the science of the laboratory and the farmer knows this already.

It might be asked: if the farmer knows these things, and if the effect of scientific workers is but to obscure what seems a simple empirical fact by enshrouding it in involved explanations, why strive to change the ancient and effective art of husbandry into a difficult if not incomprehensible science?

The answer is simple: the farmer cannot cultivate without implements; for these he has to go to the engineer. The engineer to have his chance must be given not only a clear cut problem, but also curves and quantitative data of this very kind. In the past he has had to do without this help and make an implement as best he can to the descriptions (you cannot call them "specifications") of the artist in cultivation. And so it comes about that a great multitude of implements has been laboriously evolved by the costly process of trial and error, whereas with the exact knowledge of the work to be done they could have been designed for maximum effectiveness.

We come back, then, to our starting point, that the prime function of an experiment station is to obtain knowledge, precise and well founded, and to express this knowledge in a form in which experts can use it.

DISCUSSION.

THE CHAIRMAN said it had been a great pleasure to him, and he was sure to all those present, to listen to Sir John Russell's most interesting and suggestive lecture. There would be some, at all events, in the audience who would like to discuss it further. There were several persons present who had taken a very close interest in such matters in the past, and he noticed Lord Bledisloe among them. There were so many points of contact between Lord Bledisloe and the agricultural industry that he was not quite sure in what connection he was present that night; but as a representative of the Ministry of Agriculture, at all events, he was most welcome, and also in a capacity which was even of greater value in that he has been for a long time President of the Lawes Trust.

THE RIGHT HON. THE LORD BLEDISLOE, K.B.E., M.P. (Parliamentary Secretary, Ministry of Agriculture), said he felt rather bashful in rising to initiate a discussion on the most illuminating paper submitted by Sir John Russell, because he had hoped that some of the expert scientists, who were much better able to speak on the subject than he was, would, so to speak, "open the ball;" but he did feel bound, as Lord Clinton had invited him to speak, to take that opportunity of testifying, not merely as a temporary representative of the Ministry of Agriculture, but also as a past Chairman of the Lawes Agricultural Trust Committee, to the quite invaluable work which had been conducted for so many years at that, the first agricultural research station in the English-speaking world; and also, if he might venture to say so in his presence, to the immense amount of brilliant and progressive effort which had been associated with the Directorship of Sir John Russell. Having heard Sir John Russell on many occasions, and always with great personal delight and educational advantage, he did not know that he had ever listened to a more interesting or a more brilliantly suggestive discourse than that which everyone present had found so enjoyable that evening. He thought that they owed a great deal of gratitude to Sir John Russell for coming that night in face of the very serious domestic bereavement from which he and Lady Russell had so recently suffered. That was only an indication of those qualities which everyone knew that Sir John, in a pre-eminent degree, possessed--the qualities of courage and devotion to public duty.

If he might venture to say so, the work of Rothamsted, valuable though it had been for very nearly a century, had never been more convincing to the agri-

cultural world than in recent years, partly, perhaps, because agricultural science was not now confined to such an extent within a watertight compartment as it was when that very great country squire, Sir John Bennet Lawes, initiated that splendid and historic monument to his ever-enduring memory. Formerly farmers used to be told of the valuable result of the application of certain chemicals to the soil. Recent research had taught our scientists, and through them had taught a wider audience, that chemistry did not stand alone amongst the sciences which were capable of benefiting the agricultural community, and that, in fact, if one thought in terms of chemistry only, one was sure to come to inaccurate decisions and results; and in his humble judgment it was perhaps that lack of complementary scientific knowledge which some 50 or 60 years ago created some distrust in the minds of British farmers towards the teachers of so-called practical science. Since then, of course, they had learnt, as Sir John had taken pains to point out that evening, that they had to consider as well as chemical factors the physical conditions of the soil, and, indeed, of the plants that derived nutriment from the soil. They had to consider biological effects even in the case of time-honoured farmyard manure, and particularly the bio-chemical results of micro-organic action in the soil and in the nodules at the roots of the leguminous crops, upon the successful cultivation of which it was being realised to a greater degree than ever to-day that the prosperity of agriculture was largely dependent. There was another factor which had tended, he thought, to make Rothamsted even more convincing to-day than it was in the past, and that was the splendid team-work of its most highly skilled staff working in close co-operation, the workers in one department working in the closest possible co-operation with the workers in other departments to the common good, and partly—and perhaps he might say last, but not least—the increasing capacity of distinguished agricultural scientists to speak in language which the farmers could understand. Sir John had pointed out, no doubt quite properly, that the main function of a properly equipped agricultural research station was to afford guidance to those skilled men whose duty it was themselves to afford guidance to the practical farmer, but he was quite certain that if it was desired to obtain for an institution like Rothamsted the full sympathy of the agricultural community, at least in this somewhat conservative country, it was necessary at times to bring the farmer in direct contact with the work of the research stations, and demonstrate to him that that was work of real economic value to himself and the industry in which he was engaged; and that was just the work which in recent years had been done so excellently by the present Director, than whom he knew of no man more capable of conveying valuable scientific information, not in technical scientific jargon, but in language which laymen could understand.

He was rather interested to hear that in the matter of cultivation Sir John thought that we had very little but empiricism to rely upon: that we were, in fact, only just upon the first rung of the ladder of scientific appreciation of the value of certain long-standing agricultural processes. It was curious to think that agriculture had been the chief industry of the world from the time of Adam, and yet that confession had to be made in the year 1926. It certainly showed what a great deal we all yet had to learn for our own good and for the enhanced production of food and other soil products. He thought there was no more interesting and suggestive problem which Rothamsted had studied in recent years than the practicability of making farmyard manure without the intervention of farm animals, and it might seem rather surprising to some of those who farmed in England that there was any real practical value in that discovery; but those

who had visited the Lothians in Scotland, where in a good grain year there was a most terrible waste of straw and where very few animals over a large part of that very fertile country were to be found ; or, on the other hand, those who had visited the prairie provinces of Canada and had felt positively shocked at seeing the straw being burnt upon the cornfields because there appeared to be no use for it—and there were certainly no animals on many of the farms to tread it and convert it into manure—would realise that that discovery might have very marked effects in enabling farmers to utilise to the fullest extent the straw of their cornfields, and thus enhance the output of breadstuffs throughout the world.

He did not desire to say any more, except to express the hope that Rothamsted would continue, under such enlightened guidance as it enjoyed at present, to stand always in the very forefront of agricultural science and research in the world, and in that connection Sir John would pardon him for referring to a very interesting tour which he and the speaker took two years ago, first in Canada, where they went across to the Pacific, and subsequently, having returned to Winnipeg, across the United States to California, and thence back to the Atlantic; he only referred to it because it made him feel that the value of Rothamsted was appreciated possibly in certain other parts of the world to a much greater extent than in the country where this famous station was to be found, because Sir John and he had visited together several universities and research and experimental stations, and the word Rothamsted was a talisman which opened all doors to them. They had been most royally entertained by agricultural enthusiasts throughout the whole of North America, and he might say with experience of certain other countries that exactly the same appreciation was to be found in all the progressive countries of Europe, notably in Scandinavia, about which some of them were saying a good deal in face of some criticism at the present time. There, he had found, Rothamsted was honoured as it was entitled to be honoured as the great pioneer of scientific research in the agricultural world.

Mr. M. A. F. Sutton (of Messrs. Sutton and Sons, Reading), who apologised for the unavoidable absence of his father, Mr. Martin Sutton, said he was very appreciative of the honour which had been done him in being asked to say a few words. He had listened with very great interest to Sir John Russell's paper. He had heard him on several occasions, but he must say that he had never heard a paper of greater interest than the one given that night. The point of particular interest to him, apart altogether from the manurial points in regard to root and other crops, was that of the draw-bar pull in the ploughing and manual cultivation of the land. That was a point which he had never heard before so thoroughly explained; in fact, he was not aware that experiments had been undertaken to that extent at Rothamsted. If the scientists of the country were going to lead them with investigations of so deep a nature as that, it should not be long before we in England should cease to decry the state of agriculture, but should rather look to the farmers to lead the country in the oldest industry in the world.

The Chairman, in calling upon Mr. John Porter to address the meeting, said that his contribution to the discussion would be especially welcome, because it was being recognised now that the county organisers of the country were the real connecting link between the great work which had been carried on at Rothamsted and the practical farmer throughout the country districts.

Mr. John Porter (Organiser of Agricultural Education in Buckinghamshire) said it was very good of his Lordship to emphasise the connecting link which the

county organisers had tried to form. It had been a very great pleasure to him to come up to London to hear the interesting summary which Sir John had given of the very important work which was carried on at Rothamsted. There were many points on which Sir John touched, but there was one which appealed to him as being of very great interest, and that was the work carried on at Rothamsted in testing the pull on ploughs when lime and so on had been used in the soil. Another point in which he was always interested as a county organiser was the moisture question, because they frequently came up against that question, and it was a very serious matter on some of the farms. Where, for example, there was a light soil, or a very dry soil, such as chalk, it seemed to him almost pitiful to see the moisture romping away in Spring. The farmers had not got properly hold of the principles of controlling that moisture, and if they only could get hold of those simple principles they would be able to save that moisture and thereby increase the crop considerably. There were many other things to which one would like to refer, but he would only add how fortunate he was in being located so near to Rothamsted. Sir John was very good in inviting him over on many occasions, and he was always delighted to go, because he felt that one could not go to Rothamsted without learning something which would be useful, and the way that he and his colleagues were always received at Rothamsted certainly encouraged them as county organisers to go there as often as possible.

Dr. J. A. Voelcker, M.A., Ph.D. (Member of Council), said it gave him special pleasure as a member of the Council of the Royal Society of Arts to be the medium of conveying to Sir John Russell the thanks of the Council of the Society, and of all those present that evening, for the illuminating discourse he had given. Sir John had said that Rothamsted owed its foundation to Lawes and Gilbert, and he would like to remind his hearers that there was a close connection between that Society and Rothamsted, inasmuch as it was to Lawes and Gilbert that the Society had given, many years ago, their very highest award, the Albert Medal, and it was a pleasant feature of that award that just as those two were associated together in their work at Rothamsted, so they were not divided in the honours they received from the Society. Since those days, much progress had been made, and he thought it wanted somebody who could go back to the early days fully to appreciate the changes and the progress that had taken place at Rothamsted since then. He remembered the time when, as a small boy, he was a frequent visitor staying at the house which was on the site of the present Director's house, his father being a contemporary of both those great men, and a very close personal friend, especially of Sir Henry Gilbert. He thought one of the pleasing things about the history of the Rothamsted Experiment was that successive directors had not so much altered things as improved them; they had carried them a further stage; they had not destroyed the foundation, but they had built on the foundation, and he was sure that they—as he did himself, and as did many agriculturists throughout the country—regarded with a religious love those plots at Rothamsted such as existed in Broadbalk and other fields; and it was pleasant to note that neither Sir Daniel Hall nor Sir John Russell had made the least suggestion that those venerated plots should ever disappear. They had done a great work because they had kept the work going on the same lines and at the same time brought it up-to-date. Since the days of Lawes and Gilbert there had been great progress. It might not always be realised, but there had been perhaps more encouragement given by the Ministry of Agriculture in recent years than ever before, and he thought they might take

what had recently been done at Rothamsted as being due in very large measure to the help afforded by the Ministry of Agriculture; and those who now looked on that splendid building and the enlarged farm and the many fields and experimental plots must not forget that it was very largely through Sir Daniel Hall in the first instance, and the subsequent interest which he took when he went to the Ministry of Agriculture, as also through the fact that at the time Lord Bledisloe was Chairman, that Rothamsted had been able to arrive at the position it now held, and to extend its work in the way it had done. He need not add that they had had a splendid succession of Chairmen, of whom Lord Clinton was one, and he was sure that members were glad to have him present that evening as representing the Society and as representing Rothamsted itself.

He would like, in asking the meeting to remember how much agriculturalists owed to Rothamsted, to call to mind that the work was of national importance, and deserved support from everyone. In the days of Lawes and Gilbert it was, perhaps, as far as they could go to think of the soil and what its essential features were, and how crops could be increased, but, as Sir John had said that evening, they had long gone past that, and had now to deal with such questions as the organic life in the soil, the physical nature of the soil, the effect of implements and the various ways in which they altered the soil; and, lastly, they had to deal with such things as the examination, by statistical methods, of the influence of such things as rainfall, and even an hour of sunshine. Those were the lines on which, if Rothamsted was to keep its place as it had kept its place in the past, it must be conducted, and he was sure that they had had in their Directors, and not least in their present Director, Sir John Russell, men well able to keep the work going, and to sustain the reputation of Rothamsted. He would ask those present to express their warm thanks to Sir John Russell for the work he was doing, and to his collaborators, and he was sure they would all feel that as Rothamsted began with the famous association of Lawes and Gilbert, so the co-operation which now existed would long continue for the benefit of agriculture.

REAR-ADMIRAL JAMES DE COURCY HAMILTON, M.V.O. (Member of Council), in seconding the vote of thanks, said that having spent most of his life at sea, he knew very little about farming, but in his early days he was brought up in Norfolk, and what they used there, when they could get it, was seaweed, and he thought that produced about the best crops. They had plenty of manure, and, of course, the quality of the manure depended on whether the animals were given plenty of cake. He thought it always would be so in that respect. He had very great pleasure in seconding the resolution, and as no such vote of thanks would be complete without including the very capable Chairman, he would add his name.

The vote of thanks was carried by acclamation.

SIR JOHN RUSSELL, in reply, expressed his thanks to the meeting for the way his address had been received, and for the very kind terms in which the work at Rothamsted had been alluded to. Lord Bledisloe had very properly emphasised the way in which Rothamsted kept in touch with practical farming. That was the line Lord Bledisloe had adopted when he became Chairman of the Lawes Trust. He had adhered to it through his chairmanship, and it was a line which everyone knew he had adhered to since he had been at the Ministry. One could co-operate with the farmer nowadays; he was an alert-minded person, very

different from the farmer of fiction and from the farmer in the pages of "Punch." He was alert-minded and knew his job, and was out for all the information he could get. That they owed to the country school teacher, and to the great agricultural teachers who had first convinced the farmer of the value of knowledge —to Lawes and Gilbert and to the pioneer teachers of the old universities—Sir Thomas Middleton, Professor Somerville, Sir Daniel Hall, and Professor Wood, and others whose names were perhaps not so familiar.

NOTES ON BOOKS.

University Reform in London. By Thomas Lloyd Humberstone. London: George Allen and Unwin, Ltd. 7s. *6d*. net.

Few great institutions have had to fight their way through such a contentious career as the University of London. From its foundation in 1836 it has been the cockpit of warring sects and factions. Commission after Commission has been appointed in the hope of settling the numberless thorny questions that have from time to time threatened to disrupt it, and at the present moment a Departmental Committee of the Board of Education is engaged in the task of framing a new constitution. The appearance of this volume just now is, therefore, very opportune. Mr. Humberstone has been a lifelong student of the history and problems of his university; for many years he served on its administrative staff, and it was largely due to his enthusiasm that the Officers Training Corps (of which he was Adjutant) reached its very high standard of efficiency. What he says should, accordingly, deserve the careful attention of those who are interested in the problems facing the Departmental Committee.

The first part of the book is mainly historical. The author first sketches the early days of the University, and then proceeds to discuss in more detail the work of the Selborne Commission, the Gresham Commission, and the Haldane Commission. A special chapter is devoted to the question of the site—Bloomsbury or South Kensington. Mr. Humberstone is a whole-hearted advocate of Bloomsbury, and he states his case very clearly, and with much enthusiasm. The present arrangements for the administrative staff are certainly far from satisfactory. The Imperial Institute—beautiful as it is—was not designed for the purpose of housing a large clerical staff, and if under the new organisation the work of the Institute developes as one hopes it will, it will require the whole space afforded by the building, which is now divided between the Institute and the University. If and when that happens, it will be necessary for the headquarters of the University to be moved again, and this possibility certainly is a strong argument in favour of the Bloomsbury site. At the same time, one would like to have some idea of the amount of money which would have to be raised in order to realise the dreams of the Bloomsbury partisans. Mr. Humberstone asks, "Is it not discreditable that this great city, the metropolis of an Empire which stands to-day in the comity of nations for moral and intellectual progress, has no great and impressive building dedicated to education, and resuming in its beauty and dignity London's distinguished educational record and history?" This is all very well; but the "great and impressive building" which he has in view will cost a vast sum of money. He does not attempt to estimate the amount, but it would probably be more than even this great city would be disposed to contribute; at all events, until we come to times less stringent than the present.

ROADS AND MOTOR TRANSPORT IN THE FRENCH ZONE OF MOROCCO.

In the course of a survey of the economic and commercial conditions in Morocco by H.M. Consul-General at Rabat and H.M. Consul at Casablanca, it is pointed out that the trunk road from Fez to Marrakesh still awaits completion. This is the principal road needed to complete the extensive system of roads, connecting all important points in the pacified portions of the French Zone, to which a substantial portion of the loans contracted since 1914 has been devoted. The whole system will comprise about km. 3,400 of first-class roads and km. 750 of second-class roads, in addition to a considerable number of *pistes aménagées*, which, though not classed as roads, are in some cases adequate to carry ordinary motor traffic. The system of roads links up with that of Algeria and Tunisia, so that there is direct communication by road between Casablanca and Tunis via Oran and Algiers.

Although motor transport is widely used both for passengers and goods, the actual number of motor-cars in Morocco is not great relatively to the mileage and general good quality of the roads. The total number of cars was estimated at 2,500 in 1921, and 2,250 in 1922. Since that time the number has increased, but there is room for a much greater expansion. Passenger services are run on all the main routes on highly competitive lines. The majority of the cars used are of French make. Low-priced American cars are also a good deal used and the Italian Fiat is rapidly increasing its sales. British cars continue to be almost unknown for general motoring purposes.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 8.. Brewing, Institute of, at 39, Coventry Street, W.C. 7.45 p.m. Messrs. F. E. B. Maritz and D. H. F. Fuller, "The Degree of Modification of Malt in relation to the Stability of Beer."

East India Association, at Caxton Hall, Westminster, S.W. 3.30 p.m. Lieut.-Colonel C. Eckford Luard, "Some Views of an Indian Ruler on the Administration of an Indian State."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Mr. F. Creedy, "A recent development in A.C. Apparatus."
At Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. R. B. Matthews, "Electro-Farming or the Application of Electricity to Agriculture."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Major H. I. Lloyd, "The Geography of the Mosul Boundary."

Mechanical Engineers, Institution of, Storey's Gate, Westminster, S.W. 7 p.m. Mr. S. S. Hall, "Aeroplane and Airship in Modern Air Transport."

Société Internationale de Philologie, Sciences et Beaux Arts, 8, Taviton Street, W. 3.30 p.m. The Rev. A. Graham Barton, "The Place and Street Names of London."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. G. Barcroft, "The White of the Egg."

Structural Engineers, Institution of, at Abbey House, 2-8, Victoria Street, S.W. 6 p.m. Paper by Mr. H. J. Deane.

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Discussion of papers on various Statutes of The New Law of Property.

University of London, at University College, Gower Street, W.C. 5.30 p.m. Prof. J. H. Morgan, "The Dominions and Foreign Policy." (Lecture III.)
5.30 p.m. Mr. M. H. Krishna, "Indian Archæology and Anthropology." (Lecture VIII.)
5.15 p.m. Dr. R. W. Lunt, "The Chemistry of Ionization by Collision." (Lecture VI).
At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture VI.)
5.30 p.m. Prof. Gaetano Salvemini, "The Political Evolution of Italy in the Nineteenth Century." (Lecture VI).
At University College, Gower Street, W.C. 4 p.m. Prof. A. V. Hill, "The Physiology of Muscle." (Lecture VI.)
At 5.30 p.m. Prof. Dr. J. B. Collingwood, "The Influence of Water on Vital Processes." (Lecture II.)
At University College Hospital Medical School, Gower Street, W.C. 5 p.m. Dr. R. A. O'Brien, "Active and Passive Immunity—Application to Diphtheria." (Lecture III.)
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. Ernst Herzfeld, "Persian Archæology—Sasanian Sculptures." (Lecture III.)

TUESDAY, MARCH 9.. Aeronautical Engineers, Institution of, at 39, Victoria Street, S.W. 6.30. p.m. Mr. O. E. Simmonds, "The Development of Civil Marine Aircraft."

Colonial Institute, at Hotel Victoria, Northumberland Avenue, W.C. 7 p.m.

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. Mr. R. A. Chattock, Presidential Address.

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.30 p.m. Dr. Arthur Wade, "The Search for Oil in Australia."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Annual General Meeting.

Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Dr. Bernard Hollander, "The Psychology of Genius."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Dr. C. M. Ariens Kappers "The Evolution of the Nervous System." (Lecture I.)
At the London School of Economics, Aldwych, W.C. 5 p.m. Prof. H. Kantorowicz, "The German Constitution." (Lecture II.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture VIII.)
At the Imperial College of Science, South Kensington, S.W. 5.30 p.m. Prof. A. Sommerfeld, "Atomistic Physics." (Lecture II.)

WEDNESDAY, MARCH 10. .Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Informal Meeting.

Electrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Mr. R. B. Matthews, "Electro-Farming or the Application of Electricity to Agriculture."

Geological Society, at Burlington House, W. 5.30 p.m.

Metals, Institute of, at Institution of Mechanical Engineers, Storey's Gate, S.W. 10 a.m. to 4 p.m. Annual General Meeting.
Mr. R. W. Bailey, "Note on the Softening of Strain Hardened Metals and its Relation to Creep."
Dr. W. Feitknecht, "Crystal Growth in Recrystallized Cold-worked Metals."
Mr. R. Genders, "The Interpretation of the Macrostructure of Cast Metals."
Dr. S. L. Hoyt and Mr. T. R. Schermerhorn, "The Hardness of Cold-rolled Copper."
Mr. W. L. Kent, "The Brittle Ranges of Bronze."
Mr. George Mortimer, "Die-Casting of Aluminium Alloys."
Mr. D. Stockdale, "The Copper-rich Aluminium-Copper-Tin Alloys."

Structural Engineers, Institution of, at Manchester. Mr. R. Travers Morgan, "Building Construction from a Surveyor's Point of View—A Survey of Regulations governing Buildings."

Royal United Service Institution, Whitehall, S.W. 3 p.m. General Sir Ivor Maxse, "The Territorial Army, based on suggestions put forward by the Writers of the Gold Medal Essays, 1924."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Sir Herbert Stephen, "The Conduct of a Criminal Trial."
At King's College, Strand, W.C. 5.30 p.m. Mr. C. H. K. Marten, "The Marquis of Salisbury."
At the London School of Economics, Aldwych, W.C. 5 p.m. Prof. Gilbert Murray, "The Personality of Gibbon."
At King's College, Strand, W.C. 5.30 p.m. Prof. A. S. Peake, "The Servant of Yahweh." (Lecture III.)
At University College, Gower Street, W.C. 5.30 p.m. Dr. C. M. Ariens Kappers, "The Evolution of the Nervous System." (Lecture II.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. Knut Liestøl, "Modern Saga and the Reliability of Oral Tradition." (Lecture II.)
At the Imperial College of Science and Technology, South Kensington, S.W. 5.30 p.m. Prof. A. Sommerfeld, "Atomistic Physics." (Lecture III.)

THURSDAY, MARCH 11. .Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chadwick Public Lectures, at Royal Society of Arts, Adelphi, W.C. 8 p.m. Mr. W. A. Harvey, "Housing—Past, Present and Future."

Electrical Engineers, Institution of, at University College, Dundee. 7.30 p.m. Mr. A. F. Stevenson, "Cable Troubles."
At Trinity College, Dublin. 7.45 p.m. Dr. J. F. Crowley, "Recent Developments in the Production of Synthetic Ammonia."

Historical Society, 22, Russell Square, W.C. 5 p.m. Prof. C. A. J. Skeel, "The Cattle Trade between Wales and England from the 15th to the 19th Centuries."

L.C.C. Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. H. C. Bradshaw, "St. Paul's Cathedral."

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 10 a.m. to 4 p.m. Prof. C. C. Bannister, "Note on the Corrosion of an Ancient Tin Specimen." Mr. T. B. Crow, "Some Experiments on the Soft Soldering of Copper." Messrs. B. S. Evans and H. F. Richards, "The Determination of Zinc Oxide in Brass." Mr. W. Hume Rothery, "Researches in the Nature, Properties and Conditions of Formation of Intermetallic Compounds with special reference to certain compounds of Tin." Messrs. A. Glynne Lobley and Douglas Jepson, "The Influence of Gases at High Temperatures." Mr. A. J. Murphy, "The Constitution of the Alloys of Silver and Tin." Mr. A. M. Portevin, "Striation due to working or to Corrosion in Microscopical Metallography—the mode of Action of Etching Reagents." Messrs. H. J. Tapsell and J. Bradley, "The Mechanical Properties of an Alloy of Nickel and Copper with special reference to Creep."

Mechanical Engineers, at South Wales Institute of Engineers, Cardiff. 6 p.m.

Optical Society, at the Imperial College of Science, South Kensington, S.W. 7.30 p.m.

Oil and Colour Chemists' Association, at 8, St. Martin's Place, Trafalgar Square, W.C. Mr. R. G. Browning, "Problems in the Painting of Ships." Messrs. J. Cruickshank Smith and F. B. Crow, "Notes on the Flash Points of Paints and Varnishes."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. C. D. Ellis, "The Atom of Light and the Atom of Electricity." (Lecture III).

Royal Society, Burlington House, W. 4.30 p.m.

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Mr. H. Clifford Smith, "Gothic and Early Tudor Furniture and Woodwork."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Henry Thomas, "The Romances of Chivalry Abroad."
At the London School of Economics, Aldwych, W.C. 5.30 p.m. Dr. H. W. Meikle, "The Eighteenth Century."
At University College, Gower Street, W.C. 5.30 p.m. Dr. C. M. Ariens Kappers, "The Evolution of the Nervous System." (Lecture III.)
5.15 p.m. Prof. J. E. G. Montmorency, "Customary Law in Europe." (Lecture VII).
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk-Mirsky, "Early Russian Literature." (Lecture IX).
4 p.m. Mr. I. L. Evans, "Economic Development of South Eastern Europe." (Lecture VI).
At King's College, Strand, W.C. 5 p.m. Dr. J. A. Hewitt, "Metabolism of Carbohydrate and Fat." (Lecture VIII).
At St. Thomas's Hospital, Westminster Bridge S.E. 5 p.m. Prof. Dr. R. H. A. Plimmer, "The Importance of Vitamins in Nutrition." (Lecture I.)

FRIDAY, MARCH 12. .Astronomical Society, Burlington House, W. 5 p.m.

Academia pro Interlingua, at 8, Taviton Street, W.C. 8.15 p.m. Mr. Silvio E. Corio, "Interlingua."

Mechanical Engineers, at the Philosophical Hall, Leeds 7.30 p.m. Mr. J. G. Pearce, "Foundry Practice."

Mechanical Engineers, Institute of, Storey's Gate, Westminster, S.W. 7 p.m. Kinematograph Exhibition, showing the manufacture of a 50,000 k.w. Turbine and Generator, and the Distillation of Motor Spirit.

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. James S. Hodgson, "Whaling in the South."

Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir J. J. Thomson, "Radiation from Electric Discharges."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Dr. C. M. Ariens Kappers, "The Evolution of the Nervous System." (Lecture IV).
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Making of Modern Roumania." (Lecture VI).
At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. Graham Wallas, "Social Leadership." (Lecture V).
At University College Hospital Medical School, Gower Street, W.C. 5 p.m. Dr. R. A. O'Brien, "Active and Passive Immunity—Scarlet Fever and other Diseases." (Lecture IV).
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. Ernst Herzfeld, "Persian Archæology—The Dawn of Mohammedan Art in Persia." (Lecture IV).
At St. Thomas's Hospital, Westminster Bridge, S.E. 5 p.m. Prof. Dr R. H. A. Plimmer, "The Importance of Vitamins in Nutriton." (Lecture II.)

SATURDAY, MARCH 13. .L.C.C. Horniman Museum, Forest Hill, S.E. 3.30 p.m. Dr. H. Graham Cannon. "How Animals Feed and What they Eat."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir E. Rutherford, "The Rare Gases of the Atmosphere." (Lecture II).

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FRIDAY, MARCH 12th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, MARCH 15th, at 8 p.m. (Cantor Lecture.) W. F. HIGGINS, M.Sc., Principal Assistant, National Physical Laboratory, "Thermometry." (Lecture I.)

WEDNESDAY, MARCH 17th, at 8 p.m. (Ordinary Meeting.) LIEUTENANT-COLONEL JOHN HERBERT BORASTON, C.B., C.B.E., "Co-Partnership." VISCOUNT CECIL OF CHELWOOD, P.C., K.C., LL.D., will preside.

FRIDAY, MARCH 19th, at 4.30 p.m. (Indian Section.) LADY CHATTERJEE, O.B.E., M.A., D.Sc., late Adviser to the Government of India on the Industrial Employment of Women and Children, "Women and Children in Indian Industries." VISCOUNTESS CHELMSFORD, G.B.E., will preside.

Tea will be served in the Library from 4 p.m.

FUND FOR PURCHASING THE SOCIETY'S HOUSE.

The following contributions to the Fund for Purchasing the Society's House have been received since the last announcement was published in the *Journal*:—

	£	s.	d.
Amount previously acknowledged	42,948	17	5
Sir Dorabjee Jamsetjee Tata	100	0	0
Professor John Uri Lloyd, Ph.D., LL.D. (in addition to previous donations amounting to £16 16s. 0d.)	7	2	0
Samuel Barnett, Esq.	5	5	0
Edward E. Berry, Esq.	5	0	0
James Edward Taylor, Esq.	2	2	0
Percy A. Wells, Esq.	1	1	0
	£43,069	7	5

Fellows of the Society are reminded that the amount aimed at by the Council is £50,000, which, in addition to purchasing the freehold, will cover the cost of renovating and decorating the House.

POSTPONEMENT OF MEETING.

The reading of the paper by Sir Frank Baines, C.V.O., C.B.E., on "The Preservation of Ancient Cottages," previously announced for Wednesday, March 24th, has been postponed until after Easter. As soon as the new date has been fixed an announcement will be made in the *Journal*.

There will be no meeting of the Society on March 24th.

THE LIBRARY.

For the convenience of Fellows arrangements have been made to keep the Library and Reading Room open continuously up to 8 p.m. on those evenings when meetings of the Society are held.

DOMINIONS AND COLONIES SECTION.

TUESDAY, MARCH 2nd, 1926. VISCOUNT BURNHAM, C.H., LL.D., D.Litt., in the Chair. A paper on "Publicity in Relation to the Problems of Empire Trade and Settlement," was read by SIR BASIL CLARKE, Managing Director, Editorial Services, Ltd., late Director of Publicity, Ministry of Reconstruction, Ministry of Health, and Irish Office.

The paper and discussion will be published in the *Journal* dated April 9th.

TWELFTH ORDINARY MEETING.

WEDNESDAY, MARCH 3rd, 1926. LLEWELYN B. ATKINSON, Past President, Institution of Electrical Engineers, in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

Chatterjee, Devendra Nath, B.A., B.Sc., Agra, India.
Gleave, W. H., Formby, Lancs.
MacKrow, Claude V., M.I.N.A., London.
Mersh, Charles Melmoth Bailey, M.I.E.E., Nagpur, India.
Mohanty, S., Cuttack, India.
Serner, Dr. Herbert E., Buffalo, N.Y., U.S.A.
Williams, Richard Albert Basil, London.

The following candidates were duly elected Fellows of the Society:—

Dixon, Leon Snell, Bangor, Maine, U.S.A.
Qureshi, Dr. M. Y. Badr, B.A., Jhang, Punjab, India.
Tiwari, Nagendra Mohan Prasad, B.Sc., LL.B., Datia State, India.

A paper on "Science in the Cable Industry," was read by PERCY DUNSHEATH, O.B.E., M.A., B.Sc., M.I.E.E., Head of the Research Laboratories, W.T. Henley's Telegraph Works, Co., Ltd.

The paper and discussion will be published in the *Journal* dated April 16th.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1926 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 20th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce."

The list of those who have received the medal since its institution in 1864 was printed in the last number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

NINTH ORDINARY MEETING.

WEDNESDAY, 10TH FEBRUARY, 1926.

DR. CHARLES JAMES MARTIN, C.M.G., M.B., D.Sc., F.R.S., Director, Lister Institute of Preventive Medicine, in the Chair.

THE CHAIRMAN, in introducing the lecturer, said Professor Drummond's attention was first directed to the investigation of vitamins in the latter part of the Great War, when a certain stringency in the food supply led to rationing. The services Professor Drummond rendered on that occasion were of very great value. There could be no excuse for anyone suffering from want of vitamins when it was possible to pick and choose one's food, because at the present day the supply for even the humblest breakfast table was drawn from all over the world. It was in connection with the dietary of institutions, ships, armies, children and animals that the danger arose. Professor Drummond was thoroughly conversant with the subject with which his paper dealt, and by his own investigations and those of his pupils had contributed as much as anyone in the country towards furthering knowledge on the very important question which was dealt with in the paper.

The following paper was then read:—

MODERN VIEWS ON VITAMINS.

By PROFESSOR J. C. DRUMMOND, D.Sc., F.I.C.

Professor of Bio-Chemistry, University College, London.

When I was invited by this Society to lecture on the present state of our knowledge of vitamins I was at first uncertain in my own mind which aspect of this big subject to present to you. On thinking the matter over, however, it seemed to me that if I were to deal in my remarks more particularly with the chemical aspect of these remarkable substances it might make you familiar with a point of view that is not so frequently presented as are others. To introduce you at once into what may be termed a chemical atmosphere I can do no better than to quote the remarks made almost exactly twenty years ago by Professor (now Sir) Gowland Hopkins, when he announced to

the Society of Public Analysts in London the discovery of the vitamins. On that occasion he said: " No animal can live upon a mixture of pure protein, fat, and carbohydrate, and even when the necessary inorganic material is carefully supplied the animal still cannot flourish. The animal body is adjusted to live either upon plant tissues, or other animals, and these contain countless substances other than the proteins, carbohydrates and fat. Physiological evolution, I believe, has made some of these well nigh as essential as are the basal constituents of the diet." The task of determining which of these countless constituents of natural foods are essential to the animal organism has proved, as you may well imagine, one of extraordinary difficulty, and it is by no means completed. Nevertheless, when one recalls how revolutionary the idea seemed twenty years ago that the dietary needs of animals could not be expressed solely in terms of proteins, fats, carbohydrates and mineral salts, one realises how far our knowledge in the new field has advanced. It may help to make clear to you how the progress has been achieved if I trace one path of development. Hopkins's discovery was, as you are doubtless aware, made by putting the older theories to a strict test, and finding that when the proteins, fats, carbohydrates and salts of a diet were sufficiently purified from other substances it would not serve for the growth and nutrition of young rats. The addition of a very small supplement of milk enabled the animals to grow and thrive. In time it was ascertained that at least two distinct substances were jointly responsible for the beneficial effect exerted by the milk. One of these showed a preferential solubility in fatty substances, and was, therefore, normally present in the milk fat or butter, whereas the other was found to be relatively insoluble in fats but soluble in water, and, accordingly, was mainly present in the separated milk. As you are doubtless aware, the former is now generally referred to as Vitamin A and the latter as Vitamin B. Each has a characteristic influence on growth, and an adequate supply of both is essential for normal health and development. Fed upon an artificial food mixture of proteins, fats, carbohydrate and salts and supplemented with supplies of the vitamins A and B young animals (rats) will grow at a normal rate to maturity, and to all appearances will be fine, vigorous, healthy creatures. Such results led us to believe that the vitamin requirements of the rat were satisfied by the substances A and B, but a broader view had to be adopted when an American investigator, Professor Evans, of Berkeley University, California, ascertained that although such experimental animals may occasionally reproduce and rear young when fed on the artificial ration I have just described, such is very much the exception, and that minute amounts of a dietary factor distinguishable in several respects from the substances A and B are necessary if the species is to show a normal reproductive capacity. Later I shall refer again to this most interesting substance, of which the separate identity has been accepted under the name vitamin E, but I have traced the steps leading to its discovery in order to illustrate how the complex

problem of determining what molecular units are essential components of the diet of animals and man is being solved.

Another example of a similar nature is provided by the history of the differentiation of the antirachitic vitamin (now given the label D) from vitamin A. To this I will again refer.

The constituents of living tissues can broadly be classified into two great groups according to whether they are preferentially soluble in water or in fats, themselves immiscible. Fundamentally this co-existence in the cell of the substances of the two types underlies a large proportion of the complex physico-chemical reactions that together constitute the life processes of the organism. It is not surprising, therefore, that we find essential substances such as the vitamins in both classes. The division of the vitamins into the two groups, fat-soluble and water-soluble, was at first adopted purely for convenience, but bio-chemically it is justifiable on far more important grounds. It will be convenient if we follow the classification in our discussion.

The Fat-Soluble Vitamins.

Into this class are now grouped the vitamins known as A, D and E. The first of these has, as I have pointed out, been known for relatively a long time, having been discovered by McCollum, and independently by Osborne and Mendel, in 1913, by observing the different effect of various fats on the growth of young animals.

One of the most potent fats in this connection was found to be cod liver oil, thus providing scientific grounds for the long-established reputation it acquired from the results of practical experience. It was observed that if the animal did not obtain a sufficient supply of such an oil, not only was its rate of growth depressed, but there was marked disturbance of the process of deposition of lime in the developing bones resulting in a condition closely resembling human rickets.

At that time there was, as you are probably aware, a keen controversy between two schools of thought regarding the etiology of rickets in children. On the one hand the view was held that a defective diet was the main causative factor, whilst on the other the disease was ascribed to faulty hygienic conditions, in particular to lack of exercise, fresh air and sunlight.

The researches of Mellanby clearly demonstrated that rickets can be prevented or cured by a substance present in certain foodstuffs and resembling Vitamin A in its general properties and in its natural distribution. Not entirely satisfied in his own mind that vitamin A was actually the substance responsible for the effect on bony tissues he refrained from assuming its identity with the antirachitic factor. For some time there was uncertainty whether one or more factor was concerned, until Mc Collum, by demonstrating that the power of cod liver oil to effect growth may be destroyed very much

more readily by oxidation than the power to assist the calcification processes in bone, was able to show that at least two substances must be concerned. The former substance is that to which I have referred as vitamin A, the latter has been given the designation vitamin D. Both these substances are of the fat-soluble type of vitamin, and into the same class must also be grouped the factor, vitamin E, discovered by Evans as playing an important part in the reproductive cycle.

Let us now examine the available information regarding the nature of these three remarkable substances.

The conditions of their formation in nature are as yet imperfectly understood. As is clearly shown by Dr. Coward's researches in my laboratory, Vitamin A is synthesised in green plants by the agency of the chlorophyll system and the light energy which that system absorbs. Vitamin D is formed in both plant and animal tissues, as we shall learn in more detail presently, under the action of ultra-violet light, whilst little is yet known about the origin of the factor E, except that it appears to be formed solely in plants.

The physical properties of all these substances lead to their being found in company with the other fatty components of tissues, so it is not surprising that certain of the natural fats extracted or expressed for food are amongst the best sources of the physiologically active principles. Thus, for example, cod liver oil is a valuable source of A and D, and wheat oil is rich in E.

You are probably aware that the word *fat* means to the chemist a group of substances of clearly defined composition. They are compounds of glycerol and fatty acids termed glycerides which are readily resolved into their components by treatment with alkalis (saponification). The naturally occurring oils and fats are by no means so simply constituted. It is true that they contain in most cases a high proportion, ninety-nine per cent. or so of real fats, i.e., glycerides, but there is always present a proportion of substances which cannot be so classified. The majority of these constituents are unaffected by the process of saponification, by which the true fats present are broken down by the alkali to form glycerol and soaps, and may be separated from the saponified material by extraction with a suitable solvent.

By this means we may prepare from the ordinary edible oils and fats a fraction, usually referred to as the unsaponifiable matter, which in most cases represents rather less than one per cent. of the weight of the original material. Until recently neither physiologists nor chemists paid much attention to the constituents of this material. The former concerned themselves almost solely with the study of the assimilation of the true fats and the mechanism of their breakdown in the animal body, whilst to all intents and purposes the latter were only interested in the unsaponifiable matter to the extent that its estimation would give an indication whether the oil had been adulterated or not. To-day the position is changed in a remarkable manner as a result of the demonstration that if care is taken to prevent secondary changes,

particularly oxidation, during the saponification of oils containing the fat-soluble vitamins, the physiologically active substances can be concentrated without appreciable loss in the small residue of non-saponifiable substances.

This discovery, as I have said, has tended to divert the attention of both bio-chemist and physiologist from the true fats to the study of the nature and significance of the curious substances which this residue may contain. The proportion of non-saponifiable matter containing the vitamins in edible fats, *e.g.*, butter, cod liver oil, wheat oil, is approximately one per cent., a fact which gives a prophetic accuracy to the lines Strachey wrote in his "River of Life":—

"The Analytic Chemist can assign
In every hundred, a clear ninety-nine.
The unknown Vitamin eludes his pains,
Though 'tis that Vitamin that lives and reigns."

The discovery of the resistance of the three vitamins A, D and E to the somewhat drastic chemical process of saponification, involving exposure to strong alkalies at boiling point, brought immense relief to many of us engaged in the task of ascertaining their nature, for we had always had with us the fear that these remarkable substances would be found to be ill-defined and labile agents, such as the enzymes or immune bodies. Nevertheless, the chemical examination of the unsaponifiable matter from physiologically-active oils has presented great difficulties at almost every stage, and in spite of much work during the last year or two the biochemist must still admit that "The unknown vitamin eludes his pains." A number of substances, many of them newly discovered and of curious interest to both chemist and biologist, such as the hydrocarbon, spinacene or squalene, $C_{30}H_{50}$, the unsaturated alcohols, cholesterol, $C_{27}H_{44}O$, oleyl alcohol $C_{18}H_{36}O$, phytol $C_{20}H_{40}O$, selachyl alcohol $C_{20}H_{40}O_3$ and the related saturated batyl alcohol $C_{20}H_{42}O_3$ have been isolated from the vitamin fractions of active oils, but have been shown to be without apparent physiological action. These researches have, however, given positive proof of the considerable stability of the fat-soluble vitamin molecules, which appear to contain only carbon hydrogen and oxygen, for on heating under greatly reduced pressures they can be distilled at temperatures near 200° C. (2 mm.). This line of attack may be illustrated by the scheme on the next page, which represents the progress made by my colleagues, Mr. Channon, Dr. Coward, and myself, in our efforts to isolate the vitamin A from cod liver oil.

Those familiar with chemical technique may ask why, if the active products are volatile and reasonably stable, so little success has attended our efforts to separate the vitamins from the other substances present. The answer to this question is that in the past it has proved a matter of great difficulty and one involving heavy expense to obtain a sufficient material for a fractionation on a large scale. The largest quantity of raw material we ever had at our disposal necessitated the laborious saponification and extraction of over

10,000 gms. cod liver oil.
↓ saponification with alkali.

Soaps (inactive)	100 gms, unsaponifiable matter (active).

precipitation with digitonin. ↓

50 gms. cholesterol (inactive).	50 gms. active product

↓ distilled at 1-2 mm. pressure.

bp. 180° C. (inactive).	b.p. 180-200° C. vitamin fraction contains traces of inactive spinacene.	b.p. 270-280° C. contains spinacene $C_{30}H_{50}$ (inactive) and batyl alcohol (inactive.)	residue 300° C. (inactive).

100 kilos of cod liver oil. The highly active fraction b.p. 180-200 c. (1-2 mm.) seems to consist to a large extent of unsaturated alcohols, but the evidence is as yet quite insufficient to establish the claim of Takahashi, to which you may have seen references in the lay press recently, that the vitamin is itself a substance of this type. Dr. Rosenheim and I have recently discovered colour reactions that appear to be characteristic of vitamin A. If these can be modified to render them suitable for a reasonably accurate comparison of the colour intensities, we believe that it may be possible to use them for the quantitative estimation of vitamin A in certain foods. I mention the reaction at this point in order to allow myself an opportunity to speculate on the nature of vitamin A. . No one familiar with the characteristic colour reactions of cholesterol and its related compounds can fail to be impressed by a certain general resemblance which they show to those given by vitamin A. Cholesterol itself, as we have already seen, cannot replace the vitamins in the diet, but one cherishes a belief that the active substances will be found to be related to this universally distributed cell constituent. The belief rests on what are admittedly quite inadequate foundations, but I hesitate to abandon it entirely because the researches of the last year have proved that such a relationship actually exists between cholesterol and the antirachitic vitamin D.

In 1919 Huldschinsky observed that children suffering from rickets were rapidly cured on exposure to sunlight or to the light of lamps which emit a large proportion of rays in the ultra-violet part of the spectrum. Miss Chick and her colleagues studying post-war malnutrition in Vienna, confirmed this observation and found that the disease could be cured as well by such treatment as by the administration of the usual anti-rachitic foods, such as cod

liver oil. Obviously, here lay a clue pointing to how a reconciliation between the then contending schools of thought regarding the etiology of this infant scourge might be attained. It will be remembered that of these one attributed the disorder entirely to inadequate diet, whilst the other vigorously maintained that not food alone, but defective hygienic conditions, in particular lack of sunlight and fresh air, was responsible. But, welcome as a prospect of the reconciliation of theories was, the new facts presented a difficult problem as soon as attempts were made to correlate the action of ultra-violet light with that of certain food constituents. Modern experimental research can show few more fascinating stories than that of the manner in which step by step this problem has been to a large extent solved.

The clue that led to this being achieved was detected by the American investigator Steenbock, who discovered that a food mixture, which by reason of its deficiencies will produce rickets in animals, becomes endowed with anti-rachitic potency after being exposed to the ultra-violet rays emitted by a quartz-mercury vapour lamp. This pointed to one of two things having occurred. Either the foods absorbed the ultra-violet rays, later to emit secondary radiations, in a manner similar to the phenomenon of phosphorescence, which exerted a curative action on the animal of the same type as that effected by direct exposure to the primary radiations themselves, or the absorption of the short wave-length light actually led to the formation of a substance analogous to the anti-rachitic vitamin D.

On general grounds the second alternative appeared more likely to prove correct, and subsequent studies fully confirmed this view. One by one the individual components of the food mixture, which as a whole could be "activated" by ultra-violet light, were examined, and the precursor of the anti-rachitic substance or substances was traced as being present in the oils or fats. I have already drawn your attention to the two fractions into which the components of naturally-occurring fats can be divided, namely, the glycerides or true fats on the one hand, and the relatively small amount of unsaponifiable substances on the other. Examination of each fraction revealed the fact, to many of us not surprising, that the conference of anti-rachitic potency on an inactive oil, such as linseed oil, can be traced to the action of ultra-violet light on a constituent of the non-saponifiable fraction. Almost simultaneously Steenbock and Hess in the United States, and Dr. Rosenheim, Mr. Webster and I, in this country, were able to prove that the substance which exerts so far-reaching an influence on the working of the complex mechanism for the deposition of lime in developing bones and teeth arises from the well-known substance cholesterol, or the closely-related phytosterol, under the action of the radiations. These substances, belonging to the class known to chemists as sterols and constitutionally of the nature of complex alcohols related to the terpenes, are of universal occurrence in nature, the cholesterol being characteristic of animal and the phytosterols

of plant cells. Although usually regarded as being somewhat stable in the chemical sense, being well-defined crystalline products with high melting points, their molecules are actually somewhat labile. Exposure to the radiations of the quartz-mercury-vapour lamp causes cholesterol to lose its crystalline form, to become discoloured, and to show a marked fall in melting point; signs which the chemist recognises as those due to molecular change and breakdown.

We are as yet uncertain of the conditions under which the anti-rachitic substance is formed in largest amount from cholesterol or phytosterol, nor have any clear indications been obtained up to the present of the nature of the photo-chemical change that occurs. If only that for the first time a vitamin has been prepared artificially in the laboratory from a substance readily obtainable in large amounts in the pure condition, the discovery is one of immense importance to the scientist. To the practical man, whether he be the clinician concerned with the welfare of children or the person concerned with problems of animal husbandry, the facts are equally important. Our present belief is that exposure of the surface of the skin to ultra-violet radiations, either as sunlight or in the form of suitable artificial lamplight, brings about a synthesis from cholesterol of the anti-rachitic vitamin which, otherwise, it would be necessary to supply in the diet.

The practical applications of these discoveries seem wide in their scope, and such problems as the feasibility of enriching milk and other foods during the winter months, when they naturally tend to be rather deficient in anti-rachitic power, by treatment with ultra-violet readiations may well be investigated.

Much as I would like to spend more time discussing the probable developments of the researches I have just described, I must, if I am to give a fair survey of the subject of my lecture, pass on briefly to consider the action of the fat-soluble vitamins in the animal body.

Unfortunately, it has to be admitted that the amount of reliable information on this aspect of the subject is sadly meagre. A few facts stand out, and they are without exception of a striking nature. One of these concerns the quantity of the fat-soluble vitamins that seem to be necessary for the well-being of the higher animals. Most of the research on these substances has been carried out with the rat as an experimental animal, so that it will be convenient to illustrate my point by reference to the requirements of this species. A young rat weighing about 100 grams eats on the average a little over 15 grams of dry food in the course of a day; that is, of such composite artificial rations as we employ in these experiments. This provides him with about 3 grams of proteins, 2 grams of fat and slightly under 10 grams of carbohydrates; the residue being accounted for by mineral salts and other constituents. To maintain such an animal in health and to ward off any apparent signs of a deficiency of vitamin A it is only necessary to administer daily

a one hundred-thousandth part of a gram of the highly active vitamin fractions obtained from the distillation I have previously described; that is, 0.0006% of its total food consumption. Let me give you another example. The vitamin E discovered by Evans and Bishop as being essential for normal reproduction occurs in a number of natural food products, of which one of the richest is the oil expressed from the embryo of the wheat grain. Evans and his colleague, Burr, have recently made a chemical fractionation of wheat oil by a process very similar to that I have described as being used by us in the examination of cod liver oil. In this manner they have obtained distilled fractions of remarkable potency, of which as little as 0.0005 grams will, on administration to a female rat previously rendered sterile by the deficient diet, lead to a complete recovery of fertility and the power to rear young.

The seat of action of this curious substance, which also appears to be a compound of carbon hydrogen and oxygen, is quite unknown, but it is worth mentioning in this connexion that more than one substance of this type seems to play an important part in maintaining the delicate balance of control in the reproductive cycle. The internal secretion of the ovary—long known to be an important regulator of the process of menstruation and œstrus—has not long ago been isolated in the form of a distillable oil bearing some general similarity to the volatile vitamins I have described. The administration of minute amounts of this substance will induce the phenomenon of œstrus in animals deprived of their ovaries and which otherwise would show no cycle.

Finally, the example of the vitamin D may be given, for although the minimum amount required to protect against or cure rickets in the rat is not yet known, very small doses, of the order of a ten-thousandth part of a gram, have been found effective.

When it is borne in mind that the highly active preparations I have described are admittedly far from being pure vitamins, I think that you will agree with me that the effective dosages are of the order of those we associate with the actions of the internal secretions or of certain poisons or drugs.

Regarding the actual means by which the fat-soluble vitamins bring about the effects in the animal body that we have noted practically nothing is as yet known.

Progress in physical chemistry in its application to biological problems is slowly being made in many fields. We are learning how a film of molecules, only a single molecule in thickness, may profoundly modify the properties of a living tissue. The formation of such a monomolecular film, as it is termed, of lactic acid seems to initiate the train of physico-chemical changes that causes a muscle to contract; the displacement of the normal reactants at the surface of minute granules in the living cells by a monomolecular film of an anæsthetic such as ether, or of certain poisons, brings about the inhibition of the cellular oxidations that we call narcosis. Interference with the structure of

the molecular film of fatty substances at the surface of the blood corpuscles completely changes their permeability, and may lead to the escape of the cell contents, termed hæmolysis, and virtual death of the cell. The extremely minute amount of the fat-soluble vitamins which are physiologically efficient tempt one to speculate that in this direction may lay the explanation of their action. At any rate, some such line of approach seems likely to lead to an explanation of the curious changes in permeability to calcium and phosphates—the essential building stones of the bony structures—which is shown by the walls of the mammalian gut in response to changes in the amount of anti-rachitic vitamin administered.

Water-Soluble Vitamins.

It is now time that we turned our attention to recent studies of those vitamins which differ from the fat-soluble substances in being preferentially soluble in water. There are two well-defined substances of this class, vitamin B, sometimes termed the antineuritic vitamin, and vitamin C, generally known as the antiscorbutic factor.

It is a curious fact that the former substance has been more exhaustively studied by biochemists than any other member of this class of food constituent, without any clue being obtained as to its chemical nature. Time and time again claims to have isolated it in the pure state have been made, only to be disproven by further work. What appear to be the most reliable investigations are those recently reported by Professor Peters at Oxford, who certainly has prepared materials many times more active than any previous scientist has succeeded in doing. By a long and tedious fractionation of yeast (an extremely rich source of the vitamin, as you are doubtless aware,) he has succeeded in obtaining a product, obviously still far from being the active substance in the pure state, of which as little as 0.00008 grams per day is sufficient to protect or cure a pigeon from the effects of a diet deficient in the vitamin. In somewhat similar manner Dr. Zilva has, by his painstaking experiments, succeeded in fractionating lemon juice, so as to obtain highly concentrated preparations of the active component, vitamin C, without having isolated a pure substance. Thus, from a litre of lemon juice he removed all the citric acid and sugar (the chief constituents) and finally obtained a preparation containing all the antiscorbutic potency of the original litre of juice concentrated in 0.3 gms. of substance. Of such a product, admittedly still a complex mixture, only 0.00045 was needed to protect a guinea pig from scurvy.

It is of interest to compare some of the dosages I have given by reducing them to a uniform basis, namely, that required for 100 grms. of body weight of the experimental animal.

Vitamin.	Smallest recorded effective dose in grams.	Weight of animal in grams.	Effective dose per 100 gm. body weight.
A	0.00001	100 rat	0.00001
B	0.00008	300 pigeon	0.000027
C	0.00045	300 guinea pig	0.00015
D	0.0001	100 rat	0.0001
E	0.0005	200 rat	0.00025

These figures represent, of course, only the roughest approximations, but they are of the same order, and to me it is difficult to resist the temptation to compare them with the minute doses which cause the physiological action of drugs or substances like thyroxin or insulin. We are to-day, in spite of much careful work, almost totally ignorant of the part played in the body by the vitamins B and C. The former substance is, as you are all aware, related to the human disease beri-beri and to similar pathological conditions in other species, and only recently have some indications of the part played by vitamin B in the tissues been obtained.

Beri-beri is endemic in countries in which the population subsists to a large extent on a diet of polished rice, and is characterised by symptoms, of which some appear to indicate degenerative lesions of the nerves. A condition resembling in many of its features one form of the disease in man can readily be brought about in birds (chickens, pigeons) and rats by feeding them on a diet of polished (*e.g.*, white) rice or other foodstuffs deficient in vitamin B. Moreover, it can readily be cured by the administration of rice polishings or other substances containing the active principle.

Examination of the organs of animals which have suffered from a deficiency of the so-called artiberiberi vitamin shows that most of them are atrophied and show degenerative lesions. These changes have for the greater part been very little studied, but the few that have received attention have provided information of a very interesting nature. In this connexion I would like to draw your attention to the observations made by Dr. Parkes and myself, on the influence of vitamin B deficiency on reproductions. One of the earliest tissue changes that has been detected in rats fed on inadequate diets of this type is the characteristic degeneration of the testes in the male. The amount of degeneration can be correlated with the degree of deficiency and with the time the animal has been maintained on the diet. Early cases can be cured and a normal condition of the reproductive tissue re-established by the administration of suitable foods, *e.g.*, yeast, but if the degeneration has become severe, normal dieting, although capable of restoring the weight and vigour of the animal, does not result in a return to normal fertility.

A study of the fecundity of the abnormally nourished males, mated with normally-fed females, revealed the fact that it is also correlated with the

degree of the deficiency. If a litter is produced it is usually of normal size, but the surprising fact was revealed that the proportion of males decreases both with the degree of the deficiency and with the time on the diet. This is illustrated by the following figures from a series of experiments:—

SEX RATIO OF CONCEPTIONS AFTER THE FIRST MONTH.

Diet.	Males.	Females	Total.	%Males	Probable error.
Completely deficient in vitamin B	0	0	0	—	—
Deficient diet + 1% yeast ...	29	52	81	35.8	+3.59
+ 2% yeast ...	35	43	78	44.9	+3.80
+ 3% yeast ...	82	87	169	48.5	+2.12
+ 4% yeast ...	37	39	76	48.7	+3.86
Normal	34	34	68	50.0	+4.09

An examination of the probable cause of these curious results shows that the sex-ratio is actually disturbed at conception, and that the most likely explanation is that the deficiency of the essential substance has reacted more unfavourably on one type of spermatozoa than upon the other.

The most characteristic sympton of the disease in birds is a lack of co-ordination of the muscular system that causes them to be unable to control their movements, and often produces a typical retraction of the head. For a long time past this disorder has been regarded as due to damage of the nervous mechanism, and has been classified as a peripheral neuritis, but, whilst it is true that on histological examination the nerves of such animals may exhibit signs of degenerative changes, it is equally true that the extent of these changes frequently bears no relation to the severity of the symptoms, and that they may often be entirely absent. Dr. Woollard has recently examined a number of my experimental animals, using a technique that is less open to criticism than that employed by the majority of other investigators, and has satisfied himself that the characteristic inco-ordination of the muscular system cannot be attributed to lesions of the peripheral nerves.

As far as microscopical technique is able to reveal the condition of the nerves, they may often appear normal in animals that are exhibiting typical paresis of the limbs. In the course of this examination he made an observation that might be interpreted as evidence that the muscle tissue in the experimentally produced beri-beri possess a reduced power of oxidation.

Actually, this view is in agreement with a number of other facts. Thus, it has been shown that birds suffering from the deficiency exhibit a markedly reduced respiration, which is restored to a normal level by administration of active preparations of vitamin B. The isolated tissues removed from beri-beri animals also show this depressed vital activity, as the following figures will show.

Oxygen Uptake of Muscle Tissue, Expressed in cmm O_2 per Gram per hour.

Animal.	*Medium.*	
Normal	Ringer's solution	592.2
Beri-beri (mild)	" "	306.8
"	" " + yeast extract ...	567.0
Beri-beri (severe)	Ringer's solution	77.4
"	" " + yeast extract ...	194.6

The apparent depression of the oxidative activity of the tissues in the abnormal condition produced by feeding on a diet deficient in vitamin B would, of course, account for a number of the characteristic symptoms of the disease such as the greatly lowered body temperature.

The prompt recovery which follows within an hour or two the administration of an active preparation of vitamin B is much more in keeping with the idea that such treatment supplies an agent that is necessary for the tissue oxidations to proceed normally than with the view that it restores the function of a degenerated nerve or faulty nerve-ending. To one familiar with modern views on the mechanism of oxidations in animal tissues it appears not unlikely that the substance known as vitamin B will be found to play an important part in the processes. We are at present conducting an investigation by which it is hoped to establish with certainty whether the chief cause of the disturbances of the system in experimental beri-beri is an interference with the normal course or rate of oxidations in the tissues, and, if so, what part of ths complex mechanism by which the tissues carry out oxidations is absent or rendered inactive. Directly connected with these ideas are the results of some recent studies made in my laboratory, and which, I understand, confirm those yielded by a much more extensive investigation recently carried out by Professor Plimmer. These tend to show that the requirements of the higher animals for vitamin B are quantitatively related, not as Funk at one time thought, to the amount of carbohydrate consumed, nor, as Miss Hartwell recently claimed, to the amount of protein eaten, but to the total amount of food catabolised in the body. This, after all, is what might be expected if the vitamin were part of the mechanism for effecting the oxidation of organic substances in the tissue cells. If it be true that this quantitative relationship between total food consumption and vitamin B exists, it would seem that many practical issues of immense importance may arise. It has frequently been assumed that in a country such as ours the population is in no danger of suffering from the results of vitamin inadequacy, because, since it exists on a reasonably varied dietary, there is always the chance that the deficiencies of one foodstuff will be made good by the adequacy of others. Scientists familiar with the modern work on nutrition have often warned against a complacent acceptance of such a view, but it would

seem, if the recent results are trustworthy, that it may be necessary to sound the warning with very much greater emphasis.

If the vitamin B is, as I believe it to be, quantitatively related to the total amount of food oxidised in the body, it is no longer sufficient to ensure that the diet contains *some* of this factor, it will be necessary to be certain that it contains *ample*. In my mind many long-debated questions, such as the superiority of wholemeal bread over that prepared from the vitamin-B-deficient white flour present themselves in an entirely new light if this point of view be adopted, for it seems questionable whether the diets ordinarily consumed by a large proportion of our populations do provide the *right proportion* of vitamin B to other foodstuffs necessary to maintain the health of the individual.

On this practical note I will conclude, hoping that my remarks, discursive and inadequate as they have been, have to some extent revealed to you the progress which is being made in this fascinating field of scientific endeavour.

DISCUSSION.

THE CHAIRMAN said the applause with which the paper had been greeted showed how much it had been appreciated. Vitamins provided a very good subject for a lecture, because people were always interested in what they ate. The subject was also of great interest to those concerned with infant welfare, with the dietaries of institutions and schools, and even to those who were interested in birth control, as Professor Drummond's remarks about vitamin E had shown. He had no doubt there were many questions which members of the audience would like to put to Professor Drummond, than whom there could be no one more competent to answer them. Before inviting discussion, he wished to allude to the enormous economic importance of vitamins to those interested in the raising of stock, which was a matter of very great importance to this country. Those who had applied the results of the researches of Professor Drummond and others had been rewarded by extraordinarily good and interesting results.

DR. WILLIAM WANKLYN (Principal Assistant Medical Officer of Health, L.C.C.) thanked Professor Drummond most heartily for his valuable address, and said that from the point of view of the public health, in which service he had spent his life, there was no single subject which was of greater importance than that of food and vitamins. Professor Mellanby had said that diet was the key to public health, and the truth of that observation was being brought home more and more every day. He believed that the study and the practice of correct diet was capable of revolutionising the outlook on health questions, and the root of correct diet was vitamins. He had been specially interested in what Professor Drummond had said about the deposition of lime salts, because that played a very important part in the rearing of children of all ages and classes.

There was one question he wished to ask. Like many people, he wished to be able to refer to some book or authority which would deal with the subject in question in the shortest and most accessible form. It would be interesting to be able to refer to some work on the process which facilitated the deposition of lime salts. It would also be very interesting if Professor Drummond could say where further information could be obtained on another very important matter which

he mentioned, namely, that as the total intake of protein fats and carbo-hydrates was raised, the proportion of the necessary vitamin must be raised as well.

PROFESSOR WINIFRED CULLIS, O.B.E., D.Sc. (Professor of Physiology, University of London), said her interest in the question was that of one who had to teach a group of people who, as the medical women of the future, would be vitally concerned in the maintenance of the health of the children of our cities. Her own observations had been only vicarious, being obtained through colleagues, but she felt it was extremely important for the health of the nation as a whole to obtain a better and more widespread knowledge of the subject. Much valuable work could be done by missionary efforts such as that of Professor Drummond to make clear to people who had not time to follow the literature of the subject the enormous importance, and, in a sense, the comparative simplicity of securing an adequate dietary. Food might be looked on in two ways, as a source of heat and energy and as a source of vitamins. So many people went astray by saying that white flour was not a good food, instead of saying that it was an excellent food but happened to be deficient in vitamins. It was important the general public should be made to realise the distinction.

LORD BLEDISLOE, K.B.E. (Parliamentary Secretary, Ministry of Agriculture), referred to the great present and still greater prospective value, to the stock owners of this country, of that branch of science which dealt with vitamins. As a large stockowner himself, and as one of the two representatives in Parliament of the Ministry of Agriculture, he wished to testify to the enormous value which the work of Professor Drummond, aided by that of such gentlemen as Captain Goulding, to whom he would like to pay a special tribute, had been to those engaged in animal husbandry. Even in its early stages the work which had been carried out on vitamins had proved of great practical benefit in regard to the economic and scientific rationing of stock.

It was common knowledge, for example, that those who kept pigs had derived great advantage from the careful use of cod liver oil on the one hand, and of yeast and yeast foods on the other. There was an impression—he did not know whether it was well-founded—that cod liver oil and similar vitamin A foods enabled a growing animal to make much better use of the other ingredients of its ration than was otherwise possible. That was of considerable importance at a time like the present, when a stockowner had to feed most economically if he was to be sure of securing a margin of profit on his fatting animals.

Professor Drummond had not made any very detailed reference to that mysterious vitamin which had first been heard of in California and its effect in improving the capacity for reproduction. Dr. Crewe, of Edinburgh, held that it was also of importance in determining the sex of animals while in a condition of gestation. Dr. Crewe gave to the British Association when at Toronto the year before last a most illuminating address on that subject, and indicated that a time was at hand when, with the help of Dr. Evans and others, it would be possible to feed a sow a few weeks before farrowing and be quite certain she would have a litter all of one sex. From the stockowner's point of view he could not conceive of anything more valuable than that. Dr. Crewe also showed lantern slide pictures of a hen which he had succeeded in turning into a cock. He could not help feeling, however, that Dr. Crewe would have performed a more useful function if he had been able to turn a cock into a hen!

It seemed that too much use could not be made of ultra-violet rays if certain

diseases all too prevalent nowadays were to be avoided. He did not know whether sunshine could help in that respect. It also seemed that every advantage should be taken of consuming yeast, and particularly fatty foods, such as cod liver oil, butter and milk. What he was really working round to was milk. There was a notion prevalent to-day that there was poison in the milk pail, but that was a grossly exaggerated view to take. He believed that far more children suffered very seriously through getting an inadequate quantity of milk than through being exposed to the disease germs that it was supposed to contain. In that connection he would like to ask whether the milk substitutes so often given to young children were not a serious danger, in that they might deprive those children of the vitamins which were so very necessary for them.

In conclusion he would like to testify to the value of Professor Drummond's work, which he had followed with great interest for many years, and to say that, from the standpoint of animal husbandry, he did not think there was any one man in the country who was doing more useful work from the purely economic point of view than Professor Drummond.

DR. ARTHUR HAYDON asked whether when dealing either with animals or with children the treatment should be carried out by giving the ultra-violet rays and vitamins at the same time or alternately. He would like to know whether any experiments had been carried out on that matter.

A MEMBER OF THE AUDIENCE said it would be interesting to know if it were possible to have too much vitamin.

MISS EUPHEMIA SMITH suggested that it would be very desirable if a list of the various foods which were rich in vitamins and which she, therefore, concluded would be the most nutritious, could be exhibited in public places—shops, for example—where they could be readily consulted by the housewife. Very few members of the public could attend lectures such as the one that evening, but it was essential they should be instructed as to the nature of the foodstuffs which were most valuable for them. It would also be of interest to know whether the greater part of the value of vitamins was destroyed by cooking.

MR. LLEWELYN B. ATKINSON (Past President, Institution of Electrical Engineers) said it might seem an impertinence for an engineer to speak about vitamins, but having studied the question of food both in regard to himself and others and in regard to many hundreds of animals for more than 30 years, he might be able to throw a little light on some of the questions so ably and interestingly discussed that evening. Twenty years ago he had settled for himself the minimum of proteins, fats and hydrocarbons necessary to maintain his own health and efficiency. He had read and attended lectures on vitamins for the last 11 years, and as time went on he had endeavoured to apply the information thus gained to the rearing of animals of all kinds. In doing so he had obtained very startling results.

Lord Bledisloe had referred to the breeding of pigs. There was considerable difficulty in rearing pigs in this country during the winter months. On one occasion he had taken 30 pigs which had got into a bad condition, hurdled off a piece of ground and turned them loose in it. They rooted up the ground for six inches deep, and in three weeks were as fat as anyone could wish. He suspected that was due to their obtaining the necessary vitamins from the roots and herbs which they found. He had fed hundreds of pigs regularly on cod liver oil—he

reared about 200 every year—and had tried a certain number with yeast. Yeast did not appear to help them very much; possibly they were getting enough vitamin B in other ways. He favoured adding actual lime salts to the food to go with the cod liver oil if it was desired to force the pace when rearing animals. He had obtained remarkable results with calves in that way, three weeks being sufficient to turn calves which were doing badly into very healthy animals.

The rearing of chickens in the summer months was a game at which anyone could lose money. The best time was from October to January or March, so that they could be ready for market in April or May. The result was that people tried to rear them with the aid of brooders and lamps and other things which no one could keep working properly. He had reared them indoors on stages one above the other so that hundreds could be got into a small place. He used an old stable, where by actual testing there was no ultra-violet light at all. For the last two years, by utilising the knowledge which Professor Drummond and others had disseminated on the subject of vitamins, he had bred thousands of chickens under those crowded conditions without losing a single bird from any physiological cause. They grew very fast and feathered well, but their feathers were always rather loose. If the birds were afterwards put outside the feathers would pack tightly. Occasionally one came across a bird which was not doing well, although it got exactly the same food as the others, so that it seemed in some there were physiological difficulties in using the food even with the vitamins. In that case also he added mineral salts. It might be pure empiricism, but he used oxide of iron and manganese because he believed the latter to be a very potent oxygen carrier. He had found that in other branches of chemistry.

He had also reared turkeys, which people believed could not be reared except out of doors, in an enclosed building. He had reared them in that way until they were ten weeks old, when they could be turned out without further risk. He had also reared pheasants in the same way, but there seemed to be something lacking in their diet, since they were always pecking one another's feathers and so on. Some people held that it was necessary to feed the pheasants on flies or maggots, and it was possible that flies and maggots contained elements which were important for them, for behind some of the fancies of farmers there was often hidden scientific truth.

So far as laying hens were concerned, when a large number of them were crowded in a comparatively small space—three square feet of floor space per bird—and they were shut in all the winter and laying heavily, they were apt to get what was known as layer's cramp. He came to the conclusion that that was a deficiency trouble, and started feeding dried yeast to the birds, since when the trouble had disappeared. It seemed clear, therefore, that the cramp was due to a lack of vitamin B.

Last year owing to the bad harvest he had a quantity of sprouted oats on hand—oats that had sprouted in the stacks in the fields. He used it as food for his poultry. At that time in that particular poultry house with 160 birds he was only getting three or four eggs a day, but within a week of giving the birds that food he obtained over 100 eggs a day. The change came so suddenly he was convinced that the sprouted oats provided some element which had previously been lacking.

His daughter, who took a great interest in child welfare, had told him of two cases which showed the importance of vitamins to human beings. Some years ago a child was brought into the Edinburgh School of Domestic Economy in a very bad state. It was not able to retain its food or to grow in weight. On being

given a small quantity of cod liver oil every day it began to be able to retain its food within a few days, and shortly afterwards became quite normal in every way. In another case, at a certain children's clinic a few months ago there was a child a year old who had not cut a single tooth and seemed badly nourished. It was given a few drops of cod liver oil daily and in two weeks it had cut three teeth. It had since cut the normal number, and was now quite normal in every way.

MR. F. WYATT believed Professor Mellanby had stated that the necessary vitamins could be obtained just as efficiently direct from the vegetable kingdom as from cod liver oil. He would like to know whether Professor Drummond would confirm that view. In the current issue of the *British Medical Journal* there was a leading article which said that there was considerable danger in arguing direct from experiments on animals to requirements in man. He wished to ask if Professor Drummond could give any indication of the extent to which the experiments he had conducted with rats bore on the conditions of human beings.

MR. C. CHRISTENSEN said that great strides had been made in the manufacture of vitamins, and he would be pleased to supply Professor Drummond with 15 tons, if he needed them, at 10s. a pound. Professor Drummond had stated that it was now possible to certify the presence of vitamins in foodstuffs. That might be very important. Hitherto margarine had been deficient in vitamins as compared with butter. As it was now possible to manufacture vitamins, an addition of vitamins to the margarine should make it equal to butter, and that could be done without increasing its price as much as a penny a pound. As margarine was about 8d. a pound and butter 2s., if the former could be made equal to the latter by the addition of vitamins it would be of very great economic importance for poor people. If by the colour reaction it was possible to certify the presence of vitamins in the margarine, and the manufacturers of margarine added those vitamins, the laboratory would be able to certify they were actually present. On the Continent the addition of vitamins to margarine was already practised. Very great interest was being taken abroad in the question of the commercial manufacture of vitamins.

A MEMBER OF THE AUDIENCE asked whether any attempt had been made to produce vitamin A in olive oil by ultra-violet rays or otherwise. In countries like Italy and Spain butter and milk were scarcely used at all, olive oil being almost the only source of fat. She had been told that the children of Italy were rickety. If that was so, any process by which vitamin A could be produced in olive oil would be of the greatest importance.

ANOTHER MEMBER OF THE AUDIENCE said many of those engaged in infant welfare work were accustomed to give children a great deal more cod liver oil than was necessary to secure for them the requisite amount of vitamin. It would be interesting to know if there was an optimum amount of vitamin or cod liver oil to be given for the vitamin, and if it was possible to give too much.

With regard to vitamin B, it would be interesting if it were possible to give in the form of specific foodstuffs the amount necessary to keep up the proper proportion of that vitamin. It would be interesting if Professor Drummond could suggest the sufficient amounts of specific foodstuffs containing vitamin B to be given for 100 grammes of mixed diet. It would also be interesting to have his view of Mellanby's suggestion that oatmeal was actually poorer than white

flour in vitamin action, because in oatmeal there was some physical interference with the action of the vitamin.

Dr. E. H. T. Nash, referring to the breeding of pigs, said it had been claimed that by using cod liver oil and dried yeast, it was possible to have pigs ready for the market two or three weeks earlier than would otherwise be the case, which was a very important point from an economic point of view. Professor Drummond had not mentioned the effect on the peristalsis of the vitamin intake. That was a very important point on which further light would be interesting.

Professor Drummond, in reply, said a large number of the questions put to him had been of the kind invariably raised after a lecture on vitamins—practical points such as that in regard to the effect of cooking on those substances. He had not referred to such matters in his lecture, because the title of it was "Modern Views on Vitamins," and he wished to give a review simply of the more recent work in that field, perhaps somewhat advanced in its outlook, and to leave many of the more popular aspects of the subject to the numerous books which had been already written and which contained ample information on the question. Several questioners had asked where such information could be obtained, and he would like to refer them to two books. A very concise and authoritative account of vitamins was contained in a report issued by the Medical Research Council and published by H.M. Stationery Office—Report No. 38 on "The present state of knowledge of vitamins." He thought the price was 3s. or 4s. A very readable semi-popular account had been published by Professor Plimmer called "Vitamins or the choice of foods." In both those books ample information was given about the distribution of vitamins in different foodstuffs, present views on the effect of cooking and many other practical points which several questioners had raised.

Dr. Wanklyn spoke of the effect of vitamin B on the total food intake. Work on that subject was comparatively new, and as yet no information was available regarding the proportion of vitamin B which was necessary for the food intake. An account of the experiments carried out had been published in the form of a lecture by Professor Plimmer and was about to appear in the *Transactions of the Royal Society of Medicine*. At present there was no information as to the actual proportion required.

Lord Bledisloe raised an important point with regard to the effect of milk substitutes. The question was dealt with in the volumes to which he had referred, and it was of great practical importance. There could be no doubt that a certain number of proprietary foods, unless supplemented with an adequate amount of ordinary milk were ill-balanced and likely to lead to serious disorders in children.

Dr. Haydon had asked about the action of ultra-violet light simultaneously administered with the vitamin, and had enquired whether it was better given simultaneously or alternately. He was afraid he could not answer that question. As far as was known at present the two were interchangeable. The feeding of foodstuffs such as cod liver oil supplied the vitamin direct, while exposure to radiation resulted in the formation of the vitamin in the tissue. One imagined the two methods could be applied either simultaneously or alternately.

Two speakers had raised the point of whether it was possible to take too large a quantity of vitamins. There was no reliable evidence that it was harmful to do so; on the contrary, the majority of the evidence went to show that whereas the body required certain definite amounts of those substances an excess of them did no harm. Herbivorous animals must in summer when on pasture land take in much

more vitamin than they required, but the excess seemed to be stored in the fatty tissue, while presumably the water-soluble vitamins were excreted.

It was correct that vitamin could be obtained from vegetables instead of from cod liver oil. The only virtue of cod liver oil is that so far as is known at present it is a rather more concentrated source.

As to whether experiments on animals were strictly applicable to men, that point had been raised ever since experiments on animals were first made. How far such experiments could be interpreted in the treatment and study of human disease was a difficult question to answer, but there could be no doubt that experiments on animals had resulted in the almost complete elimination of human beriberi in the East in districts where it could be treated. There could also be no doubt that experiments on guinea pigs and monkeys had rendered infantile scurvy practically extinct, and Professor Mellanby and other workers in the United States and in this country had rendered rickets a disease which was inexcusable in a civilised country.

Mr. Christensen raised the question of the commercial production of vitamin preparations. That was a difficult subject, and he would rather like to have a few tons of Mr. Christensen's vitamin preparation! He himself had spent large sums of money and many months of work in getting ten grammes. He would be interested to examine Mr. Christensen's preparation, but had not so far had an opportunity of doing so. He imagined there was a commercial opening for such substances, although as long as it was possible to obtain very powerful active foodstuffs from a natural source he was not certain the scope for artificial vitamin preparations was as wide as might be thought.

So far as Professor Mellanby's work on oatmeal was concerned, Mellanby suggested that in addition to the negative factor in oatmeal there was also a positive factor which produced rickets. Personally he was not competent to express an opinion on that. Those who were sufficiently interested would find the question discussed in a small monograph by Mellanby, recently published by the Medical Research Council.

So far as the agricultural application of knowledge on vitamins was concerned, he himself had seen very many striking examples of improvement in nutrition of farm animals after administering such foodstuffs as cod liver oil.

On the motion of the Chairman, a hearty vote of thanks was accorded to Professor Drummond for his lecture, and the proceedings then terminated.

TUNG OIL.

Tung oil is of two kinds, red and white. The latter is superior in quality and is largely exported.

Tung oil from various producing districts of Szechwan province is named Chwan Tung. The products of Hungkiang, and elsewhere in Hunan province, receive the general name of Chi Low. The tung oil from Paiho, Shensi province, and Yunyang, Kunchow, Laohokow, and Siangyang, Hupeh province, is called Siang Tung. Siangyang, however, is only a trade centre, and not a producing district. Szechwan gives the largest supply, and Hunan a larger supply than either Hupeh or Shensi. Trade is usually transacted in Hankow; but now exporters also purchase directly from Chungking, Wanhsien, Changteh, Shasi, and Ichang, and have established refineries in Chungking, the most important producing centre. The trade is carried

on in the following manner: The producer sells to an oil firm, which in turn contracts with another firm doing a large business in future delivery. The latter firm sells the product to exporters. It is then tested on a refining scale. It must have a minimum grading of 40, the highest grade not exceeding 52. On future delivery sales, the product is to be identified with the sample, weighed, and then refined by the exporter. The seller is paid according to the net amount of refined oil.

Of the 17 exporting firms in Hankow only one is Chinese and one American, Messrs. Gillespie and Sons, but the last named, according to the "Chinese Economic Bulletin," is the largest and most important of the entire group. An increase in the number of German exporters to seven, it is pointed out, shows a decided improvement in Sino-German trade conditions.

The price of tung oil jumped to the neighbourhood of Tls. 50 a picul in 1921 and 1922, the highest level ever reached. The market in 1923 was more steady, but became less brisk in 1924. The exports from Hankow from 1918 to 1922 were: 1918, 479,640 piculs; 1919, 688,580 piculs; 1920, 547,491 piculs; 1921, 435,134 piculs; 1922, 370,172 piculs.

Manufacturing processes: (a) Pressing at high temperature. The seeds of tung trees are thoroughly dried in the sun, powdered in a mortar, and separated from the skin by sieving. After having been heated in a pan for 20-30 minutes, the mass is taken out, wrapped in a piece of hemp cloth, and pressed for half an hour. The residuum is again powdered down, heated and pressed as before. The oil at each pressing is allowed to settle down separately, or filtered after being settled down for some time. The simplest method is to fry the seeds to dryness in a pan, and then powder the dry mass in a stone mortar, separate it from the skin by a sieve, and finally press it. (*b*) Pressing at ordinary temperature. The seeds are dried in the sun, powdered down, and removed from the skin as in the first process; but after sieving, the mass is pressed without being heated over a fire. The white tung oil for exportation is usually prepared in this way.

Tung oil contains fatty acids in liquid and solid forms. The liquid fatty acid is oleic acid, and the solid fatty acid is an isomeric compound of linolic acid, probably formed from elaeomargaric acid. These results were obtained, however, from analyses of Japanese tung oil, which is believed to differ slightly in composition from Chinese tung oil.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 15..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. General Meeting.

Electrical Engineers, Institution of, at the University Liverpool. 7 p.m. Messrs. J. E. Allan and A. G. Barnard, "Electricity on Board Ship."
At Armstrong College, Newcastle-on-Tyne. 7 p.m. Informal discussion on "Power Station Economics."
At the Cleveland Technical Institute, Middlesbrough. 7.15 p.m. Mr. R. B. Matthews, "Electro-Farming or the Application of Electricity to Agriculture."

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Col. H. S. L. Winterbotham, "The Surveys of Canada."

Société Internationale de Philologie Sciences et Beaux Arts, 8, Taviton Street, W.C. 3.30 p.m. Mrs. Hylda Ball, "The Significance of Names."

Transport, Institute of, at Queen's Hotel, Birmingham. 6 p.m. Mr. A. G. Marsden, "Industrial Traffic Management."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. The Rev. Canon V. F. Storr, "Revelation."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. H. Schneider, "Heldensage und Heldenepik des deutschen Mittelalters." (Lecture I.)
At King's College, Strand, W.C. 5.30 p.m. Dr. E. Minns, "The Russian Icon." (Lecture I.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. J. H. Morgan, "The Dominions and Foreign Policy." (Lecture IV.)
At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture VII.)
At St. Thomas's Hospital, Westminster Bridge, S.E. 5 p.m. Prof. Dr. R. H. A. Plimmer, "The Importance of Vitamins in Nutrition." (Lecture III.)

TUESDAY, MARCH 16..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.15 p.m. Dr. G. Landtman, "Some Agricultural Rites of the Kiwai Papuans."

Egypt Exploration Society, Burlington House, W. 8.30 p.m. Dr. H. R. Hall, "Scarabs."

Electrical Engineers, Institution of, at 17, Albert Square, Manchester. 7 p.m. Mr. L. C. Grant, "Developments in High Power Fusible Cut-Outs."

Metals, Institute of, at the University, Sheffield. 7.30 p.m. Mr. G. B. Brook, "Aluminium: Where and How it is Made."

Philosophical Studies, British Institute of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.15 p.m. Prof. Alexander, "Artistic and Cosmic Creation."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. W. B. Ferguson, K.C., "Standardization of the Measurements of Photographic Density." Messrs. T. Thorne Baker and W. A. Balmain, "The Effect of Colour Sensitiveness on the Gradation given by a Photographic Plate."

Physiology, London College of, 8, Taviton Street, W.C. 8.15 p.m. Mr. C. J. Tabor, "Bi-sexualism."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. C. H. Desch, "The Growth of Crystals." (Lecture I.)

Roman Studies, Society for the Promotion of, at Burlington House, W. 4.30 p.m. Dr. James Curle, "The Romans on the Upper Rhine."

Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Major P. Granville Edge, "The Growth of Mortality due to Motor Vehicles in England and Wales, 1904-23."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. Mr. R. E. Morley, "Transport from a Trader's View-Point."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. H. Schneider "Heldensage und Heldenepik des Deutschen Mittelalters." (Lecture II.)
At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Sir Bernard Pares, "Russia from Peter the Great to 1861." (Lecture IX.)
At St. Thomas's Hospital, Westminster Bridge, S.E. 5 p.m. Prof. Dr. R. H. A. Plimmer, "The Importance of Vitamins in Nutrition." (Lecture IV.)

WEDNESDAY, MARCH 17..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. J. G. Kimber, "The Production of Gaseous Fuel."

Constructive Birth Control, Society for, at Essex Hall, Essex Street, W.C. 8 p.m. Mr. E. J. Lidbetter, "Social Inadequacy and the 'Size' of the Family."

Electrical Engineers, Institution of, at Mappin Hall, St. George's Square, Sheffield. 7.30 p.m. Mr. S. Evershed, "Permanent Magnets in Theory and Practice."

Hygiene Institute of, 28, Portland Place,, W. 3.30 p.m. Dr. R. Scott Stevenson, "Affections of the Ear, Nose, and Throat and their Prevention."

Meteorological Society, 49, Cromwell Road, S.W. 7.30 p.m. Prof. Dr. Sydney Chapman, "Some Recent Advances in Atmospheric Physics."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. W. C. Bolland, "Sir John Fortescue." 5.30 p.m. Dr. E. Minns, "The Russian Icon." (Lecture II.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. Knut Liestol, "Modern Saga and the Reliability of Oral Tradition." (Lecture III.)

THURSDAY, MARCH 18..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Aeronautical Society, 7, Albemarle Street, W. 6.30 p.m. Flight-Lieutenant H. Cooch," Landing Aeroplanes in Fog."

Child-Study Society, at 90, Buckingham Palace Road, S.W. 6 p.m. Miss C. von Wyss, "Spiders as a Nature Study Topic."

Chemical Society, Burlington House, W. 8 p.m. Messrs. R. J. W. Le Fevre and H. E. Turner, "Orientation Effects in the Diphenyl Series. Part II. The Constitution of Bandrowski's Dinitrobenzidine." Messrs. H. N. Ing and R. Robinson, "The Orientating Effect of Free and Bound Ionic Charges on Attached Simple or Conjugated Unsaturated Systems. Part I. The Nitration of some Benzylamine Derivatives." H. S. Cahn and R. Robinson, "The Morphine Group. Part IV. A New Oxidation Product of Codeine."

Evolution Society, 8, Taviton Street, W.C. 3.30 p.m. Admiral J. N. Thompson, R.N., "The Evolution of the British Navy."

Electrical Engineers, Institution of. Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. L. C. Grant, "Developments in High Power Fusible Cut-Outs."

Linnean Society, Burlington House, W. 5 p.m.

L.C.C. Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Arthur T. Bolton, "The Furniture of Robert and James Adam, 1758-1792.

Mining and Metallurgy, Institution of, Burlington House, W. 5.30 p.m.

Mechanical Engineers, Institution of, at Merchant Venturers' Technical College, Bristol. Mr. W. Nelson Haden, "The Engineering Problems of a Hospital or Institution."

Metals, Institute of, at 85-88, The Minories, E. 7.30 p.m. Dr. C. J. Smithells, "The Preparation and Structure of Wires of Pure Tungsten."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Holland Rose, "The Indecisiveness of Modern Warfare." (Lecture I.)

Royal Society, Burlington House, W. 4.30 p.m.

Tropical Medicine and Hygiene, Royal Society of, at the Royal Army Medical College, Millbank, S.W. 8.15 p.m. Laboratory Meeting—Demonstrations by Prof. Warrington Yorks, Dr. P. A. Buxton, Col. Clayton Lane, Col. W. P. Mac Arthur, Drs. A. C. Stevenson, C. M. Wenyon, H. H. Scott, J. G. Thomson, and A. Robertson.

Victoria and Albert Museum, South K,ensington, S.W 6 p.m. Mr. C. E. C. Tattersall "Handwoven Carpets."

University of London, at the London School of Economics, Aldwych, W.C. 5.30 p.m. Sir William Beveridge, "Economic Problems of War."
At University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. H. Schneider "Heldensage und Heldenepik des deutschen Mittelalters." (Lecture III.)

FRIDAY, MARCH 19..Engineering Inspection, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. Elliott A. Evans, "Lubricating and Allied Oils."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. G. H. Willett, "Pipe Lay-out for Power Stations."

Medical Officers of Health, Society of, 1, Upper Montague Street, W.C. 5 p.m. Dr. W. D. Champneys, "Cancer from the Point of View of Public Health Administration." Dr. C. P. Childe, "Cancer from the Point of View of the Surgeon." Dr. W. D. Newcome, "Cancer from the Point of View of the Research Worker." Dr. F. E. Allen, "Cancer from the Point of View of the General Practitioner."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Mr. Alan E. L. Chorlton, "The High Efficiency Oil Engine."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. H. Bairstow, "Photography as a Medium of Art Expression."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Mr. John Tweed, "Chips from a Sculptor's Studio."

Structural Engineers, Institution of, at Great Northern Hotel, Leeds. 6.30 p.m. Mr. C. A. Harding, "Some Preliminary Factors affecting the Design of Industrial Buildings."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. J. Isaacs, "Shakespeare as Man of the Theatre."
5.30 p.m. Dr. E. Minns, "The Russian Icon." (Lecture III.)
At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. Graham Wallas, "Social Leadership." (Lecture VI.)

SATURDAY, MARCH 20..L.C.C. Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. C. Daryll Forde, "Agriculture and the Origin of Civilisation."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir E. Rutherford, "The Rare Gases of the Atmosphere." (Lecture III.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, MARCH 22nd, at 8 p.m. (Cantor Lecture.) W. F. HIGGINS, M.Sc., Principal Assistant, National Physical Laboratory, Teddington, "Thermometry." (Lecture II.)

POSTPONEMENT OF MEETING.

The reading of the paper by Sir Frank Baines, C.V.O., C.B.E., on "The Preservation of Ancient Cottages," previously announced for Wednesday, March 24th, has been postponed until after Easter. As soon as the new date has been fixed an announcement will be made in the *Journal*.

THIRTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 10th, 1926. Owing to the unavoidable absence of SIR THOMAS HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, the Chair was taken by DR. R. LESSING, Ph.D., M.I.Chem.E.

The following candidates were proposed for election as Fellows of the Society:—

Beinecke, Fritz W., Madison, New Jersey, U.S.A.
Davidson, John Marcel, Salisbury, Rhodesia.
Ditcham, Vernon, L.D.S., North Berwick.
Gill, Frank, O.B.E., M.I.E.E., London.
Jackson, P. S., M.I.E.E., Calcutta, India.
MacCormick, Sir Alexander, M.D., Sydney, Australia.
Murad, Professor F. D., Aligarh, India.
Olliver, A. M., London.
Paterson, Clifford Copland, Wembley, Middlesex.
Powell, Albert Richard, Kempston, Bedford.
Singha, Prufulla Kamal, Bhagalpur, India.

The following candidates were duly elected Fellows of the Society:—

Leutz, Charles Ronald, Long Island, New York, U.S.A.
Pai, K. Rama, Calcutta, India.
Phillips, Henry Lawrence, London.
Templeton, Walter Breakenridge, Chicago, Illinois, U.S.A.

A paper on "The Microstructure of Coal," was read by REINHARDT THIESSEN, Ph.D., of the Bureau of Mines, U.S. Department of Commerce.

The paper and discussion will be published in the *Journal* dated April 23rd.

CANTOR LECTURE.

MONDAY, MARCH 15th, 1926. MR. W. F. HIGGINS, M.Sc., Principal Assistant, National Physical Laboratory, Teddington, delivered the first of his course of three lectures on "Thermometry."

The lectures will be published in the *Journal* during the Summer recess.

PROCEEDINGS OF THE SOCIETY.

TENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 17TH, 1926.

ADMIRAL OF THE FLEET, SIR HENRY JACKSON, G.C.B., K.C.V.O., D.Sc., LL.D., F.R.S., in the Chair.

The paper read was :—

THE PROPAGATION OF ELECTRIC WAVES.

By J. E. TAYLOR, M.I.E.E., Superintending Engineer, Post Office Telegraphs, South Midland District.

As, year by year, new and important facts have emerged into the light of day in consequence of practical development and research in wireless communication, so it has become necessary to adapt explanations to fit the latest results and, if possible, to reconcile the basic theory with the new turn of events.

From the earliest days the progress of the art has been marked by a curious succession of unforeseen developments. Some of the more salient of these will be referred to.

At its earliest inception the potential utility of electric waves as a practical method of communication was looked at askance. Such waves were held to have a very limited scope as compared with heliographic, semaphoric and such like methods making use of rays of light. The curvature of the earth alone, would, it was predicted, impose a quick limit to the range over which it would be found possible to utilise them. The comparative immunity of electric waves from the baneful effects of adverse atmospheric conditions as fog, mist and rain was, however, a saving factor so that its possible utility at sea was perhaps the one aspect which served to give it a practical and financial interest. That it should ever develop into a means of communication over more than a few miles was regarded as highly improbable.

When, for the first time, Marconi successfully bridged the Straits of Dover, scientific authorities began to cast around for a theoretical explanation of

this quite unexpected result. Why was it the earth's curvature had so small an effect on waves which should follow the ordinary optical laws and should therefore be propagated in straight lines? It was, however, argued that with waves of so great a length the assistance given by diffraction together with the smaller energy losses in transmitting over sea instead of land formed a sufficient explanation. An element of considerable surprise also arose from the comparatively small detriment to the waves occasioned by their passage over irregularities of land surface such as hills and valleys.

The immense step forward made when Marconi succeeded in transmitting signals consisting of the letter "S" steadily repeated, across the Atlantic from Poldhu, Cornwall, to St. John's, Newfoundland, next came as a further profound surprise. The announcement was, in fact, received with marked incredulity and many were content to assume that atmospheric electrical disturbances had been mistaken for transmitted signals; it being then sufficiently obvious that diffraction alone could not explain the result. In due course corroboration was forthcoming by transmission to ships at comparable distances and it was then realised that the explanation must be moulded to the facts. In the course of these long distance developments, it became evident that the transmission conditions *en route* varied from time to time, more favourable conditions existing at some periods and seasons of the year than at others. Prominent among these were the fluctuations of signal strength as between the daylight and night conditions, the periods of most favourable transmission being obtained during certain hours of darkness. This fact indicated an effect of solar radiations on the atmosphere as being at least a contributing factor in the variations. During daylight hours the solar rays would produce an ionisation or state of partial conductivity of the atmosphere facing the sun, especially in the outer layers, which would render the air less transparent to the waves by day. But this explanation still left untouched the problem of the deflection of the waves from a straight course so that they followed round the curvature of the earth. In view of the magnitude of the bending, diffraction no longer afforded a satisfactory solution and high authorities considered that an explanation was necessary, rectilinear propagation of the waves being taken as an axiom. This standpoint led to the hypothesis of a permanently ionised layer in the upper atmosphere in addition to the more transient ionisation of an inner layer during daylight. The permanently ionised layer was assumed to be capable of reflecting or refracting the waves, so confining them to an atmospheric shell of which the surface of the earth was the lower boundary. This ionised region was later termed the "Heaviside Layer," and was supposed to have a relatively sharply defined under surface at night so as to produce reflection of the waves downwards. Under day conditions the ionisation extended below the permanently ionised layer and the sharpness of demarcation became less, so rendering reflection of the waves doubtful. To meet this difficulty a

theory was developed, supported by mathematical calculations, by which the bending process could still be carried on by ionic refraction of the waves producing an increased velocity of travel in the less highly ionised parts of the atmosphere. Despite the rather large assumptions involved in this argument it carried much weight and received support in high quarters. With some further modifications rendered necessary by the emergence of still further phenomena, it is the prevailing view to this day. The further phenomena will be referred to later.

Following on the long distance achievements, expressions of opinion as to the monopolisation of the ether by transmitters radiating the large amounts of power used in communicating long distances, were circulated. Such transmitters would shout down or " jam " the smaller stations, thereby curtailing the utility of wireless communication in general. Tuning of receivers to different wave lengths was prophesied to be comparatively ineffective in mitigating the evil. Fortunately these predictions were not confirmed. The tuning was found to be much more effective than was anticipated whilst, also, improvements in methods of transmitting and receiving gave superior selectivity. The invention of the Poulsen arc method of continuous wave transmission carried this selectivity by tuning to a still further degree of refinement.

To achieve satisfactory long range communication it was almost universally held that long waves and high power were essential. Short wave transmitters were unable to deal with more than a limited amount of power, whilst, in addition, the waves would be weakened at a more rapid rate in transit owing to increased surface losses. As regards the extra short waves now being so largely experimented with and applied the very suggestion appears to have been looked upon as a lamentable display of ignorance at the time of the commencement of the Great War. Insuperable difficulties in generating such waves were expected. Be that as it may, the official decision appears to have been taken to pursue the development entirely in the direction of using as long waves and as great power as possible, with the result that the increased ranges are being obtained only at great cost and large supplies of radiated energy are being pumped into the electrically defective parts of the atmosphere.

In the succession of unforeseen developments the detrimental effects of unfavourable electrical conditions of the atmosphere figure largely. These consist not only of the day and night variations of signal intensity and the ordinary static disturbances but also transient " fading " of signals when they pass through comparatively slow but very pronounced variations in strength. A distinct effect of the latter character is the " sunset effect," which usually holds up communication entirely for a period each day on long distance work with long waves. Yet another effect in this category seems to be asserting itself in that it appears to be extraordinarily difficult for waves to pass over the Polar regions of the earth.

One of the accepted doctrines of wireless communication is that long ranges over sea are necessarily very much more easily obtained than over land, because the specific resistance is less in the former case. This anticipation has been realised in practice only to so limited an extent as to occasion much surprise.

On the laws governing variation of range of communication with transmitter antenna current, wave length and effective heights of antennae, many attempts have been made to formulate a mathematical expression to pre-determine the type of station required to ensure commercial communication. No reliable expression has yet been evolved applicable to long ranges. In nearly every case the expressions have been based on the assumption that rectilinear wave propagation is involved plus a hypothetical deflecting agency. Since they also assume that long waves are required for long ranges they naturally fall to pieces against short wave results. Out of the mass of accumulated observations on long wave signal strength that have been made, one striking fact may be said to have emerged in that the night signals, variable though they be, tend towards a fixed limit of maximum strength though no such limit appears to have been found for day signals. The fixed limit towards which the night signals tend appears to agree with the view that waves guided by the earth's surface are concerned. It also indicates that maximum night signals constitute normal transmission whilst day signals are subnormal.

Perhaps the least expected resulted of all is the recent short wave development. Whether by beam or broadcast, it has been shown that extra short waves can be used over the maximum distances available on this planet, when generated by only a small fraction of the energy necessary with the older long wave methods, and that they are not subject to the same day and night variations nor to the same degree of static interference. These results conflict with prevailing theoretical views.

It is one of the objects of this paper to get the theoretical views better adjusted if possible. With that idea one point in connection with the assumed ionised layer in the atmosphere will be cleared up before proceeding further. This region has become known as the " Heaviside Layer." Now Heaviside would have been the last man to admit its validity in the sense in which it has been applied. The late Mr. Oliver Heaviside was a mathematical and physical genius of a very high order and it is due to his memory to have this matter put right. To make the issue clear the so-called Heaviside layer is taken to be defined as a supposed permanently ionised region existing in the upper atmosphere, without the assistance of which the bending of electric waves round the curvature of the earth could not be accomplished. Now if the article written by Mr. Heaviside, in 1902, for the Encyclopœdia Britannica and incorporated in Volume III of his Electromagnetic Theory, be referred to, it will be seen that the whole tenour of the article turns on

the ability of waves to accommodate themselves to conducting surfaces, and that he clearly indicates that they climb around the earth's surface quite apart from whether or not an ionised layer exists. The relevant part of the article reads as follows :—

"This guidance is obviously a most important property of wires.

"There is something similar in 'wireless' telegraphy. Sea water, though "transparent to light, has quite enough conductivity to make it behave as a "conductor for Hertzian waves, and the same is true in a more imperfect manner "of the earth. Hence the waves accommodate themselves to the surface of the "sea in the same way as waves follow wires. The irregularities make confusion "no doubt, but the main waves are pulled round by the curvature of the earth, "and do not jump off. There is another consideration. There may possibly "be a sufficiently conducting layer in the upper air. If so, the waves will, so to "speak, catch on to it more or less. Then the guidance will be by the sea on "one side and the upper layer on the other."

Clearly all that Heaviside meant to convey by his reference to a possible conducting layer was that the existence of such a layer might limit the upward expansion of waves and so conserve the wave energy. It was certainly not intended to be used as an alternative method of bending the waves to the earth's curvature. The whole context refutes this interpretation.

It must have occurred to many others besides Heaviside that the rectilinear propagation view could not be reconciled with the everyday aspects of wireless communication, as exhibited by the ability of the waves to reach aerials situated in the back yards of houses in large cities, or of their faculty of accommodating themselves to large and abrupt changes of level in the general contour of the land ; in fact their obvious faculty of getting round, over or through thousands of obstacles which, on the rectilinear propagation view, should prove insurmountable barriers. If electric waves obeyed optical laws it would be expected that well defined shadows of impervious objects would be thrown, that valleys out of the direct line of propagation would not receive any radiation, and so on. The wireless antenna itself has no good optical analogy.

It was considerations of this kind which led the writer to the view expressed nearly twenty-seven years ago that guided waves are concerned. At that time the bridging of the Straits of Dover had just been accomplished and in the writer's article on "Electric Radiation," published in the *Electrical Review*, for May 19th, 1899, he made the prediction, which has since been amply confirmed, that the curvature of the earth would not impose a limit on range of communication. This, it may be remarked, was three years before Heaviside's article in the Encyclopaedia Britannica, in which he expressed practically equivalent views.

The guided wave view disposes of the necessity for invoking the assistance of an ionised layer in the atmosphere whilst it does not deny that some degree of ionisation may, and indeed must, exist, at least in the sunlit portion

of the atmosphere and near the poles where it concentrates. On this view the effect of such a layer would be largely, if not entirely, a detrimental one. A radical re-adjustment of fundamental ideas is involved, not only of electric wave propagation itself, but as to the cause which produces guidance and its bearing on the everyday uses of conducting wires to guide electric current flow. It also raises the question why there is no such guidance in the case of the minute waves giving light and heat radiation.

These matters are capable of a rational and satisfactory solution, but it would be much beyond the scope of this paper to do more than attempt a brief survey of the kind of solution which can be given. To do this it will be desirable to probe a little into the mechanism of dielectric and conducting materials in relation to their electrical reactions. Here again much may be learned from the writings of Heaviside where a degree of insight is displayed which it is doubtful whether the dominant school of thought has yet properly appreciated; otherwise less would be heard of the flow of electrons along conductors and more of the energy transmission by the dielectric part of a circuit; less of electronic motions and more of electronic fields of force. Following the methods of Faraday and Sir J. J. Thomson, the matter will be treated mainly from the electrostatic point of view. That is, Faraday's conception of electric fields of force will be used, but with the underlying modification introduced by Sir J. J. Thomson, which implies that lines or tubes of force are never called into being, but exist through and permeate all space at all times. Normally they lack organised arrangement and cancel out one another's effects in the gross, except when a preponderance is created in one direction. This modification enables a simple view to be taken of what constitutes a magnetic field. It can be regarded as "the momentum of moving tubes of force." Faraday's conception is amplified and completed in other necessary respects by this view. In the main, however, it will be possible to treat of resultant fields only and avoid undue complication. An ether is assumed but the effects concerned could no doubt be hung on to a space geometry or other conception if necessary.

For purposes of electrical theory it is only the electrical aspects of matter that are of concern to us. Electric forces or electric fields can only be changed by interference from other electric fields. Forces of any other nature are without effect. Hence in this connection matter may be regarded as entirely electrical in its constitution. It even appears probable that in empty space there exists a system or network of electric fields or electric stresses, not evident in the gross, which are perhaps systems of self-closed lines of force. and in virtue of which the propagation of electric waves through space is rendered possible. Magnetic force is embraced as being only a particular aspect of electric force whilst mass or inertia are likewise to be regarded as electrical quantities. The atoms and molecules of matter consist of minute compound systems of electric fields starting from protons and

ending on electrons. These minute fields are immensely more intense than any electric fields artificially produced. It is these minute electric fields which are called into play and upon the re-adjustment of which depend the various electrical manifestations occurring in practical applications. To the way in which these fields can re-arrange themselves to produce a gross resultant effect we must look quite as much as to the motions of electrons. It has always been regarded as something of a mystery why a charge spreads or runs along a conductor and various views, which the author holds to be erroneous, have been expressed about deficits of electrons at one place and surpluses at another and so on. The important fact appears to be that the particular molecular field arrangement spreads, both in the dielectric and the conductor. The lines of force constituting the external field simply slip along the molecular lines of force in the conductor without pulling charges or electrons along with them. Just as when a conductor is moved out of an electric field the lines of force join up and leave the conductor without pulling electrons with them, so the converse effect can take place that the molecular fields of the conductor join up with the external field when the conductor is moved in, without electronic movements being directly involved. That is, the process by which an external electric field slips along a conductor primarily depends on the joining up of successive molecular lines of force with the external field. Only in so far as it is an imperfect one is there any loss of energy in this slipping process. This view is implied by Heaviside, where he draws a clear line of demarcation between "conducted" and "convected" currents and points out that the current along a metallic conductor is not a convected current.

So far as dielectrics (that is, insulating substances) are concerned, it is common ground that the molecular electric fields are self-contained, or at any rate stable, in their character. They are not prone to interfere with one another. The electrical system of one molecule is not upset by coming into relative proximity with that of a neighbouring molecule. It will be understood that molecules are made up by the combination of one or more positive ions with one or more negative ions, the parts of any chemically divided molecule being likewise ions. These ions are, in themselves, compound electrical systems on a smaller scale than the molecular systems.

In electrolytes whilst the molecular electric systems are unstable the ionic systems are still stable in general, as in a dielectric. The result of the molecular instability is that the positive and negative ions are continually changing partners in the course of the normal molecular activity, evidenced as temperature. Apart from the application of electric stresses the interchange is chaotic, but when stress is applied the interchange becomes more or less organised and an "ionic drift" is produced determining a deposition of positive ions at one pole where the stress is applied and negative ions at the other. The interchanging of ions in a substance constitutes "ionisation."

The law of increase of conductivity with increase of temperature in electrolytes is obviously complied with on this view. The imposition of a drift on the normal chaotic interchange does not involve dissipation of energy. Only in so far as the interchanges are not sufficiently frequent to cope with the influx of fresh applied stress is there dissipation of energy. The insufficient rate of interchange results in certain molecules or molecular groups acting as dielectric molecules when they hold or trap parts of the applied stress and cause dissipation of energy in the electrolyte. The trapped energy accentuates the molecular motions and evidences itself as heat. Electrical energy is, of course, taken up in forming the new constituents of the electrolyte, but this is not energy dissipation.

In metallic conductors it is the minor electric systems in the ions, in other words the atomic internal electric systems themselves, that are relatively unstable. For some reason the atomic fields of a metal are so constituted that electronic interchanges occur between neighbouring atoms. Each atom has, as it were, an outer range into which some electrons make excursions and returns. Those which make the more extensive excursions are liable to come into the range of neighbouring atomic fields when they exchange venue. Here again the interchange of electrons is normally chaotic but becomes in some small degree organised under the influence of an impressed electric field and the "electronic drift" is produced. On the view here outlined metallic conductivity is determined by the rate of electronic interchange proper to the particular metal and the particular temperature. It does not assume that there are free electrons in the metal, only that the electrons become available in the act of interchange, and is closely akin to Sir J. J. Thomson's alternative theory of metallic conduction, which was framed to obviate the difficulty arising from a serious discrepancy between the free electron theory and the facts relating to the specific heats of metals. Obviously also, the absence of any necessity for making the large assumption that numbers of free electrons float about between the atoms of conductors is, in itself, a strong point. The view here expressed, unlike Sir J. J. Thomson's, does not demand a pre-polarisation of the conducting molecules. It assumes that in the course of normal activity of the sub-atomic electrical systems, that is, the fundamental electrical systems in which the protons and electrons are directly concerned, a sufficient number of electronic exchanges are occurring in approximately the right direction to accord with the impressed electric force in the conductor, so that they are already amenable to its influence. In other words, a number of the atoms are already polarised in the direction required to meet the demands of the impressed force. That conductivity increases with fall of temperature in pure metals is accounted for on this view by the reasonable assumption that, as the atoms pack slightly closer, more electron paths come within interfering range of neighbouring atomic fields and the rate of electronic interchange becomes greater. As in

electrolytes the true conduction is effected without dissipation of energy. Resistance losses arise solely from the failure of the electronic interchanges to take place at a sufficient rate to dispose of the impressed stress completely. The part of the stress not disposed of by handing on in the direction of wave propagation is partly absorbed by the conductor, producing accelerated molecular movement; and partly again emitted into the dielectric as a lateral field; that is, a field at right angles to the electric force in the wave proper. This lateral field corresponds entirely to the fall of potential along the conductor proportional to resistance. The effect of this lateral field on the wave propagation will be referred to later. It is important.

From what has been said in reference to electronic drift and electronic interchanges, it might be inferred that the function is to hand on electric charges. In the author's opinion this is a misleading, if not a wrong view. The function is to restore to normal the state of the molecular fields in the conductor *after* the handing on of the impressed electric force of the wave, and so put the molecular fields into a condition to conduct subsequent applications of impressed force. The assumption is that in conductors and dielectrics alike there exist available prepared stress paths for the transmission of wave fields. The interconnecting and changing electric fields of the molecules and atoms provide these paths. But whilst the disturbance of the molecular field arrangement following the passage of impressed stress corrects itself in conductors it is not so in dielectrics. The electronic interchanges in conductors relieve the state of stress superposed on the molecular fields and so, to some extent, prevent the setting up of a counter stress or opposing E.M.F. In dielectrics the counter stress set up balances the impressed stress and prevents further influx. The correction in conductors comes about by field re-adjustments made possible by the electronic interchanges.

In Fig. 1, some attempt is made to convey a concrete idea of the kind of process which produces conduction in metals, by analogy with an electric circuit, in which rotating pairs of condensers, oppositely charged, take the place of atoms or molecules. If a sufficient number of the rotating pairs of condensers be connected in parallel, one or other will, at any instant, be in position to allow of the passage of a charge, and will have its normal charges restored immediately afterwards. The restoration of charges corresponds to the readjustment of molecular fields by electronic interchanges.

The molecular fields of conductors are self-restoring, those of dielectrics are not. This is the essential difference between the two. Wave conduction is equally present in both cases, but the conduction is transient in the dielectric because of the sustained opposing E.M.F. built up in it. The rapid decay of the opposing E.M.F. in conductors enables the conduction to appear as a continuous state.

In reality it is a very discontinuous state as referred to the separate mole-

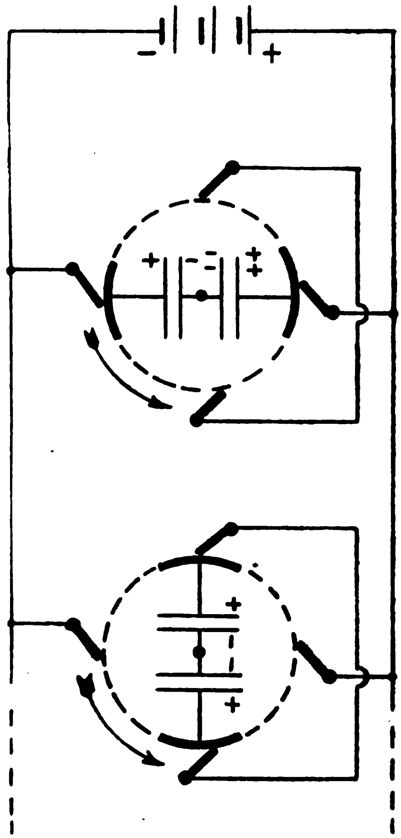

FIG. 1.

cules or small group of molecules of the conducting substance under a continuous electric stress. Such a group is essentially dielectric in its character, but exhibits conducting intervals when it may be said to be perfectly conducting, because there are no dissipation losses occurring during these spasms of conductivity. In this sense there may be said to be only rates, but no degrees of conductivity. The proper view of an imperfect conductor is that it is a dielectric to which is added the conductivity characteristic to a greater or less extent.

It may be urged, with some reason, that it is not fair to put forward unsupported fundamental views and definitions before these have been independently examined and little more will be said in that connection, except to point out that the views are to a large extent implied and even supported by Heaviside in Vol. III. of his "Electromagnetic Theory." This applies especially to the criticism of the electronic drift views to which Heaviside expresses his antipathy in several places. Thus on page 50 :—

"I am rather prejudiced against the view that in a solid conductor the conduction "consists of a continuous flow of electrons or of J. J. Thomson's corpuscles "either one or both ways, and I think it more likely to be a local phenomenon "in the main."

Again on page 354 :—

"But the discovery of the electron does not in my opinion, furnish any reason "for retrograde ideas in electromagnetics, even though the precise nature of "metallic conduction remains somewhat vague, in the absence of a knowledge "of facts relating to atoms and electrons which would determine it definitely."

His remarks on page 342 in the same connection are also worth reading.

It is only because it is of the first importance that fundamental ideas should be correct that the subject is introduced. There is no desire to belittle analytical methods of investigation. The powerful weapon of attack embraced by mathematical skill is capable of resolving a great many problems in physics, but accuracy in the basic premises is essential.

There is, however, one other important theoretical deduction that will be mentioned. The slipping of electric waves along conductors by the interaction of molecular lines of force with the wave field must not be taken as implying that wave guidance by conductors is thereby brought about. With a perfect conductor the wave field would slip off at the first bend or curve. This would not be the case with an imperfect conductor, because the lateral electric field given out by the conductor produces a tilted resultant wave front. Now applying Poynting's theory which states that the direction of propagation is normal to the wave front, it follows that the wave propagation is diverted *towards the conductor*, the tilt being a forward one. This is, in the author's view, the effect which gives wave guidance in all its aspects and without which there could be no currents in wires. It also indicates that the practical engineer would have ltittle use for perfect conductors. This leads to the question as to why then are not luminous waves guided by conductors likewise? The answer appears to lie in the inertia of the electron. The change in direction of the wave field in a luminous wave is so excessively rapid that it is unable to exercise any control over the movements of the electrons during the electronic interchanges. For these waves there is no absorption of energy by the conductor and hence no wave tilt. The full explanation, however, hardly concerns the present subject.

The extent of the wave tilt produced by resistance in broadcast transmission over the surface of the earth will vary chiefly with the distance from the source of oscillation, being very pronounced at short distances and becoming less as the annulus or ring of current at the surface expands outward until it is in general almost imperceptible at large distances, though never negligible. It will also vary with the local resistance of the ground over which the wave passes. This will have a corrugating or distorting effect upon the advancing annulus and wave front, because the horizontal component

of the velocity of travel will be slightly decreased where extra tilt is given. On the other hand there will be a slight increase of velocity at places where the tilt is decreased, as when a part of the wave front reaches the sea or ocean surface. The latter effect seems to be indicated under certain conditions of use of wireless direction-finding apparatus. Such distortions will also tend to produce positions of interference at places beyond the locality of distortion, owing to retardation of phase of parts of the wave front.

Major irregularities of surface contour doubtless also give rise to wave distortion and interference positions, not only because of the indentations in the wave front, but by reason of partial reflection of waves where sufficiently steep gradients of surface are encountered. In such cases a part of the wave is reflected and a part climbs over the surface. The latter part will have its velocity of travel up the gradient retarded to an extent depending on the increase of wave tilt relative to the gradient, and will reach localities beyond with a retarded phase producing interference with wave rays arriving by routes with different characteristics. This argument can be expressed in another way by considering an abrupt change of gradient or excrescence as intercepting the wave and producing an oscillating electric field which acts as a new wave source in much the same way as a wireless receiving antenna arrests a part of an oncoming wave, oscillates and gives out a new wave 180 degrees out of phase with the original and with the antenna as centre of wave propagation. Where the reflection is complete any point in the shadow region beyond may be considered as subject to a force due to the original wave and another equal and opposite force due to the secondary wave. Hence there is complete annulment of the wave in that region and a true optical shadow is produced. But where the reflection is only partial, as is no doubt the case when surface excrescences are met, part of the wave climbs over and part sets up a new oscillating centre or wave source, giving out a secondary wave opposite in phase in the direction of propagation of the primary wave, and thus producing a degree of interference. This will not, however, result in a shadow in the optical sense because the effect is quite local. The secondary wave produced will be rapidly diverging and therefore rapidly weakening, whilst the divergence of the primary wave will depend upon the distance from its source. In general the original wave will speedily overpower the secondary wave as the obstacle is left behind.

It will be well at this stage to emphasise the essential differences between oscillations and waves. An oscillation is a wave source from which, as centre, the waves proper proceed in all available directions. The waves have a velocity of travel or propagation depending on the character of the medium in which the propagation is occurring. The oscillation or centre of disturbance remains fixed in position and has no velocity of translation. That is, it is not propagated, and is therefore sometimes called a standing wave. In a pure electric oscillation the energy oscillates between the electric and magnetic

forms, corresponding to potential and kinetic energies in mechanical oscillations. The electric and magnetic fields are, therefore, 90 degrees out of phase. In a pure electric wave, on the other hand, there is no oscillation as between the two forms of energy. The electric and magnetic forces co-exist in exact phase and the wave energy is equally divided between the two. The oscillating field at the centre of disturbance merges gradually into the wave as the centre is departed from. Until a true wave is formed the field has an oscillating component and a wave component, the one decreasing and the other increasing as the centre is receded from. So long as an oscillating component exists, to that extent the field acts as a source of additional waves sent out radially from any point in the field. In other words, to the extent that the electric and magnetic forces are out of phase the field is reactive and the power factor is less than unity. Hence an impure or immature wave, such as the author considers is concerned in wireless communication, gives reactance, and some part of it is reflected back against the main direction of travel. It would appear then that the test as to whether or not true wave propagation has been reached in any particular case is to find out whether any of the energy is reflected back upon the source. Apparently in all cases of broadcast waves from upright antennae such reflection does exist. The matter is, of course, subject to further test with

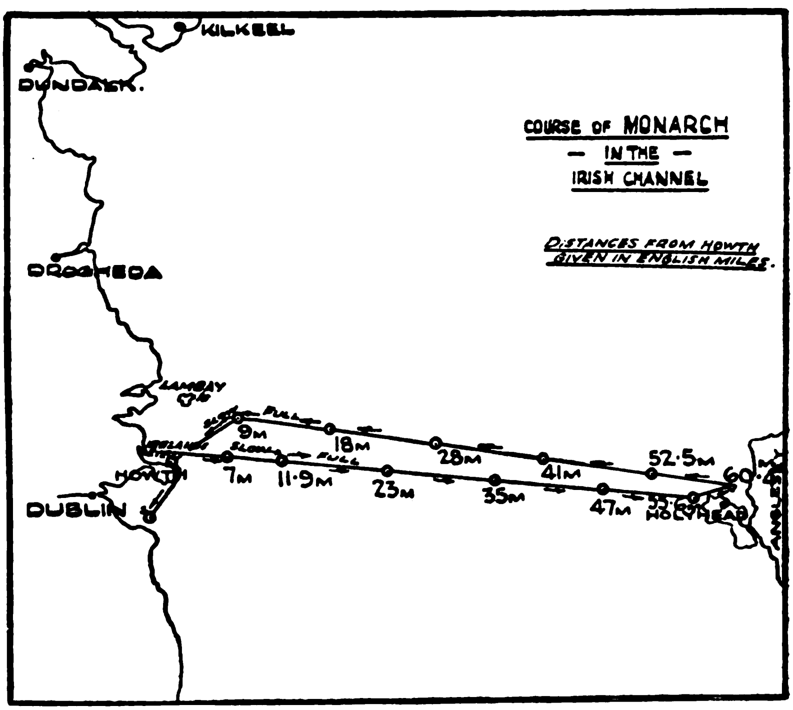

Fig 2.

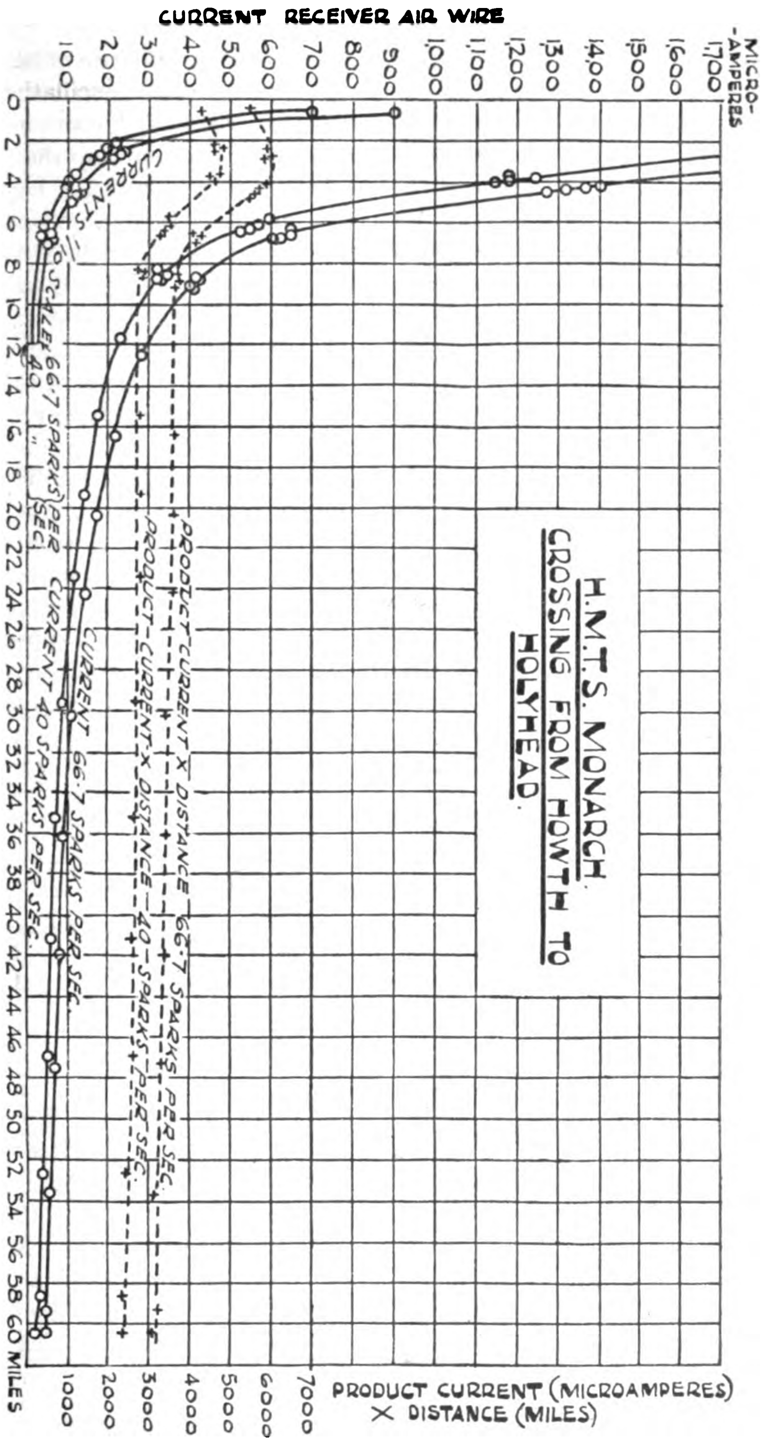
CURRENT RECEIVER AIR WIRE
MICRO-AMPERES
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 MILES
1000 2000 3000 4000 5000 6000 7000
PRODUCT CURRENT (MICROAMPERES) × DISTANCE (MILES)
H.M.T.S. MONARCH.
CROSSING FROM HOWTH TO HOLYHEAD.
CURRENTS 1/10 SCALE 66·7 SPARKS PER SEC. 40 " "
CURRENT 40 SPARKS PER SEC.
CURRENT 66·7 SPARKS PER SEC.
PRODUCT CURRENT × DISTANCE 66·7 SPARKS PER SEC.
PRODUCT-CURRENT × DISTANCE 40 SPARKS PER SEC.

FIG 3.

the specific object of proof, but measurements of received current strength at varying distances from a transmitter always seem to indicate quite marked wave reflection at short distances. Thus in the curves of received currents from a transmitter on the Post Office cable ship "Monarch," given in a paper read before the Institution of Electrical Engineers in 1905 by the late Mr. Duddell and the author, it will be seen (figs. 2 and 3) that the current by distance curves show a marked hump at the shorter ranges. This may be due to several causes, but it fits in very well with back reflection, at any rate as a contributory cause. If proof is obtained on this point then the nature of the waves emitted can no longer admit of doubt. A continuous throwing back of the wave energy upon the source can only occur with immature electric waves, but not with free waves, since it is due to the remanent oscillation component in the waves. The same effect is familiar in the case of telephone currents along cables.

There existed at one time a widespread fallacy that an electric wave consisted of a travelling electric vibration, suggesting that as the wave progressed on its normal course it oscillated constantly between the electric and magnetic states. Even now it is sometimes queried whether the electric and magnetic fields in the wave are in phase. Though the point is capable of strict mathematical proof the truth of the proposition will, no doubt, appeal better to the practical engineer from the consideration that, if they were not in phase, the system of fields would be reactive, the power factor being less than unity, and therefore would throw back energy towards the source in just the same way as a reactive circuit reacts upon the source. In other words the system would act as a centre of disturbance spreading its energy into the surrounding medium instead of preserving its general form.

In regard to the comparatively recent discovery that extra short waves are not subject to the same day to night variations as the longer waves, the explanation is no doubt to be found in the fact that the wave base is so short as between its positive and negative extremities on the surface of the ground that the force exerted in an upward direction rapidly diminishes with distance above the base. That is, the waves have a diminished upward expansion, so that very little of their energy reaches the electrically defective atmosphere in the ionised region, affected by sunlight. This is a result that might very well have been predicted on the guided wave view.

The further discovery that waves are practically unable to traverse the polar regions of the earth indicates an electrically defective atmosphere in those regions, which probably extends right down to the surface of the ground. If so, the effect will apply quite as much to short as to long waves. An electrically defective atmosphere in the polar regions is to be expected as a result of the concentration of atmospheric ionisation evidenced in the luminosity of the aurorae, combined with the probability that the ionic drift finds its way through the lower atmosphere to earth in the polar localities, whence it

continues through the ground in the form of earth currents. This does not exclude the possibility that the ionic drift may sometimes find its way through the lower atmosphere in other localities, especially in mountainous regions. If so, certain types of strays may be explained. Further, it is not altogether unlikely that spasmodic, though no doubt feeble, ionic drifts through the lower atmosphere may be rather widely spread, affording a possible alternative explanation of some fading effects, though this view is only tentatively advanced.

The sunset effect is, it is suggested, to be looked for in interference between waves passing both ways round the earth. When sunset occurs at a transmitting station using long waves they will get a good start on the dark side, but a bad start on the sunny side, with the result that the waves traversing the long path may reach the receiver not much more attenuated than those traversing the direct path and may be out of phase. A suitable temporary change of wave length may result in putting them more or less in phase at the receiver. The attenuation due to defective atmospheric states is, of course, much more pronounced near the transmitter, because the field strength determines large energy losses in that region, the energy losses being proportional to the square of field density.

Similarly there are explanations which appear likely to the author of other peculiarities of wave transmission once the guided wave view is accepted, but these must be reserved for future treatment, otherwise this paper would be unduly lengthened, as indeed, it perhaps is already.

Broadly speaking, it is the author's view that it is to the interaction of electric fields and their manipulation that we must learn to look for accurate fundamental explanations rather than to motions of electric charges or electrons, and that it is necessary to bear in mind that such electric fields are never created or destroyed, either in material substances or in empty space. It is only the organisation in some small degree of pre-existing forces that is possible. In material substances concentrations of these forces occur, but in empty space there are, apparently, no concentrations, and that is why it is suggested that the fundamental electric fields of empty space exist as closed electric lines of force. It is believed that a real insight into the mechanism of electric wave propagation is to be obtained only in this way. To adapt the mind to Nature's ways and to learn the language in which she is trying to convey her secrets to the intellect of Man is as much, if not more, a necessity than the attainment of great mathematical skill in the problems of physics.

The author desires to record his thanks to Mr. G. F. Mansbridge, M.I.E.E., for reading through the draft of this paper, and for suggestions as to clarifying the method of expression.

DISCUSSION.

THE CHAIRMAN (ADMIRAL OF THE FLEET, SIR HENRY JACKSON), in opening the discussion, read the following message which had been sent by Mr. Marconi to Mr. Taylor: "I very deeply regret being unable to be present at the reading of your paper at the Royal Society of Arts this evening, on account of a previous important engagement which I am unable to forego. I have hurriedly read the proof of your paper, and think that your suggestions may be helpful in solving the mystery (so far) of long distance radio. It must be gratifying to you to know that you came to many of your deductions so long ago when the art of wireless was still very young."

Continuing, the Chairman said that in his paper the author firstly dealt with the various attempts of the mathematical physicists, as the distances of wireless communication increased, to obtain a satisfactory explanation of the reasons that their propagation was apparently not rectilinear, but followed the curvature of the earth. Their periodical variations in intensity brought in a new factor and added to the difficulty of obtaining a formula which was applicable to all conditions, and, as the author truly remarked, the high power with long waves station was considered the only solution for many years, and no formula had been evolved which covered all conditions, unless some factor in it was modified to suit the varying circumstances, although some of them might be applicable on a globe with no atmosphere. It must, he thought, be admitted, from the results obtained during the last quarter of a century, that the atmosphere played an important part in radio communications, and also that the earth played a very important part, and what that part was, quantitatively, was not fully known at present. He had heard of no one who questioned the part played by the ether in the transmission of electro-magnetic waves, and though it might not have really proved that there was an ether, the laws which governed them in their passage through it seemed to have been well established. Scientific research workers aimed at getting the truth about any phenomena which they were investigating, and an audience such as was present that evening must, and, he felt sure, would look into the theory put before them by the author of the paper carefully and without prejudice, in order to judge if it helped to elucidate the theory of the propagation of wireless waves over the earth's surface. As he personally laid no claim to be a mathematical physicist, he would not attempt to criticise the author's explanation of the effect of electrical stresses on conductors and insulators, or on the semi-conductors which form such a large part of the earth's surface, but he would state that he did not clearly see how that affected the issue before them, as the laws of the effect of those stresses were, he presumed, well known, and practical daily experience had proved their validity in areas of limited dimensions in which their results could be measured. Possibly one part of the problem was to find out if those known laws were also applicable to the areas of vast dimensions through which wireless waves were propagated, parts of those areas being out of the reach of human beings, and not at present capable of being scientifically investigated. He therefore left it to the audience to discuss the author's theories and see if they could help to elucidate the fascinating problem of the cause of the periodical variations of intensity and direction experienced daily in wireless receivers, and, if so, to suggest experimental research which would be necessary to put the theory on a sound footing in the world of radio science.

MR. G. F. MANSBRIDGE, M.I.E.E., echoed the suggestion of the Chairman, that the matter should be looked at with an unbiased mind. He had been reminded of a remark made many years ago by Mr. James Swinburne, who, in discussing electrical

problems, had pointed out that when one was examining the results which one had obtained one should be careful to allow for the "coefficient of involuntary mendacity." Obviously nobody present would be mendacious, but he did emphasise the word 'involuntary." If he might, he would leave his remarks at that stage because he knew that the views on both sides of the subject were inclined to be very strong.

DR. R. L. SMITH-ROSE said the subject of the paper was of very great interest to him as he had been investigating it for the last few years. He had been rather disappointed in the paper, because he had hoped that Mr. Taylor would have given in terms of the theory a fairly complete explanation of what were now well-recognised and well established facts in the phenomena of the propagation of wireless waves over the earth's surface. The theory was not new, except in the detail. It had been elaborated to some extent. It was well known that Mr. Taylor had been the promoter of the theory for a good many years, and Dr. Elihu Thomson in America was also a supporter of a somewhat similar if not identical theory.

He desired to draw attention to one or two difficulties in accepting the theory as outlined that night, and also to draw attention to a few experimental results which he thought supported the contrary theory—which was that waves were deflected (they might be reflected or refracted, it did not matter which) from the upper portions of the earth's atmosphere, and did not travel horizontally along the earth's surface.

When he had started out about four years ago to study the problem, he had had a definite bias against the Heaviside Layer theory. First of all, there was the question as to whether the layer had a sharply defined lower surface or not. He was not quite sure whether he had understood Mr. Taylor correctly, but he believed that Mr. Taylor did admit that the under-surface of the layer was not very sharply defined. In that case it was difficult to understand how the waves, when they travelled upwards through the earth's atmosphere, caught on to that layer and were then guided round between the upper layer and the earth. In the absence of a sharply defined surface he failed to see how one got the propagation of a wave guided along by an upper and a lower conductor.

Another point was the question of the forward tilt of the electric force. As Mr. Taylor had represented it, he thought it was quite correct, and Mr. Taylor might have already seen the results of some experiments which had been carried out by Mr. Barfield and himself, in which they had measured the angle of the forward tilt of that electrical force at the earth's suface.* The one point to which he would draw attention, and which had been borne out by those results, was that, first of all, the forward tilt was surprisingly small. On wave lengths above 2,000 metres that forward tilt, for propagation of waves over land as it was in England, was less than 1°; that was to say, the electric force was not tilting forward at something like 20° or 30°, as was represented in the usual diagrams; it was only on quite short wave lengths below 1,000 metres where one could get any appreciable tilt. On the broadcasting band of wave lengths one did begin to get a forward tilt which was just measurable, of the order of 2° or 3°. With a tilt of that order it was very difficult to explain how a wave could bend round a conductor of the curvature equal to that of the earth.

Another point bearing on that was that as one went away from the transmitting station, that forward tilt decreased. He thought that that was what Mr. Taylor had said—that as the distance of the observer from the transmitting station was increased, that forward tilt decreased. That was quite contrary to what Mr.

* Proc: Roy: Soc: A. Vol. 107, p. 587, 1925.

Barfield and himself had found in their experiments. The tilt depended only on the resistance of the earth and the frequency or wave length. There was no measurable change of the forward tilt with distance from the transmitting station. Mr. Taylor had said that as a result of that forward tilt the waves (since the waves were travelling at right-angles to that electric force) were travelling in a downward direction. First of all, that entailed a feeding in of energy into the earth. Instead of the waves being fed along the earth's surface horizontally, they were being transmitted actually down into the earth, and therefore so much energy was being lost; and since that forward tilt increased with a decrease in wave length, more energy was being supplied into the earth at the shorter wave lengths. That energy was dissipated as heat in the resistance of the earth, and as that tilt increased very rapidly for very short wave lengths, it meant to say that the attenuation of very short waves due to earth resistance losses was very high, and therefore it would be very difficult to transmit short waves over the earth's surface. If one took the theoretical equations—unfortunately there were not enough measurements available at the moment, but he thought the results which had been obtained bore out the idea that on wave lengths of 20 or 30 metres it was very difficult to transmit those waves to any great distance along the earth's surface.

Another thing which followed from that forward tilt was the following. Mr. Taylor explained that as a result of that forward tilt, the waves being propagated downwards with their normal velocity, the velocity of the wave along the earth's surface was less than the normal velocity of the wave over a perfect conductor. If that question were looked into a little more carefully it would be found that the result was exactly the reverse. The velocity of the wave along the conductor when it was tilted forward was greater than the velocity of the wave when propagated over a perfect conductor. It was a simple geometrical problem to show, but if one imagined that forward tilt increased very considerably, to nearly horizontal, then it was quite evident that, although the wave might be proceeding in the downward direction with its normal velocity, the electric line of force was rushing along the earth's surface at a very much higher speed. In fact, if the forward tilt were increased to 90° the electric line of force would meet the earth's surface in all places simultaneously, and therefore the effective velocity of that wave along that surface would be infinite.

Mr. Taylor had made some reference to the operation of obstacles acting as oscillators and then re-radiating their energy. That re-radiation would take place in all directions both backwards and forwards, and so one might get a supply of energy in the reverse direction to that in which the transmitting station lay. If one made experiments with tuned aerial systems, one found that the effects of re-radiation from such stations were relatively very feeble. Effects could be determined within a short distance of the aerial. But if one went to three or four wave lengths away from that aerial—a tuned aerial which was receiving signals from a distant transmitting station—the effect in the neighbourhood was almost negligible compared with that of the transmitting station itself. A very sensitive means of determining that was to use a direction finder in the neighbourhood of the aerial, because then the direction finder would give the direction of the distant transmitting station, and if one then set up an aerial in the neighbourhood and tuned it, any secondary field which was produced by re-radiation from the aerial would affect the field being received by the direction finder and would produce an error in the readings of that direction finder. Such an error was only appreciated when within a very short distance of the aerial; and, moreover, it was only appreciated when the aerial was accurately attuned to the wave length of the incoming waves. He failed to

see, therefore, how any ordinary natural obstacle, such as hills or trees, could act in a very efficient manner as a re-radiator of waves received from a distant transmitting station.

In that connection Mr. Taylor drew attention to the evidence brought forward in his experiments carried out in the Irish Channel, which indicated that definite reflection did occur from the cliffs behind the ship as it was leaving port. Personally, he thought it was admitted that that was a reflection effect. Mr. Taylor had been using a wave length of the order of 100 metres, and it was well known that a cliff, if it had a height comparable to or greater than the wave length in use, would act tolerably well as a good reflector; but it was very noticeable that in the curves exhibited giving the product of current and distance the effect of that reflector was not in any way felt at any appreciable distance from the wave itself. As soon as the ship was out in the open sea the effect of that reflector was negligible. If similar experiments were carried out over a bigger expanse of sea, he failed to see how one could explain variations in signal strength from the straight line law which was plotted in the diagram as the effect of reflection from obstacles which must be situated in the land probably hundreds of miles away.

Mr. Taylor had made the statement that short waves could not go up to the top of the earth's atmosphere. Personally, he did not quite understand why. He had tried to explain that it was very difficult indeed to send waves along the earth's surface. It was known that short waves could go tremendous distances, and if they did not go along the earth's surface, which way did they go? In that connection he might draw attention to a collection of results which had been published recently in the Proceedings of the Institute of Radio Engineers,* where a very large amount of information was collected as to the effective range of a given transmitting station with an assumed power input on different wave lengths. The results showed quite clearly that on wave lengths below 100 metres one could transmit in daylight along the earth's surface at distances up to something like 50 miles. Beyond that it was very difficult, or impossible, to receive anything until one got out to a distance of 400 miles, when signals once again came in and became strong. The interval between the 50 miles and 400 miles was commonly referred to in America as the " skip distance " or " jump over," indicating the part of the earth's surface on which it was practically impossible to receive signals. The only reply which Mr. Taylor had to that was that after one had got to 400 miles one was receiving the waves which had come all the way round the earth the other way. The results showed that it was impossible to transmit a wave length along the earth's surface for more than 30 miles. How, then, was it possible for a wave to go round the earth the other way, a distance of nearly 24,000 miles?

Another point which he should have thought was a ready means of checking the theory was to set up a direction finder with modification provided for determining the absolute direction. They knew that direction finders were subject to certain variable errors, but those errors were not, on the majority of wave lengths, sufficiently large to leave any sort of doubt as to whether the wave was coming in from the front or back. On wave lengths above 500 metres there was an enormous amount of data now available, which showed that the maximum error which could be got on a direction finder was about 90°. The average error was very much less than that, but that was the extreme error. A variation from the true direction of more than 90° was never obtained. What happened, then, to the waves which were supposed to be coming in from the back, which would give an error of 180° if they arrived from that direction?

* Proc: Inst: Radio Eng: Vol: 13. p 677, 1925.

Actually, when transmission was taking place all round the earth, and one used a sense finder in that manner, it was noticeable that the waves during a certain part of the day came round the earth one way, and then, with the change of the path of the sun, the direction of travel of the waves actually changed through 180°, and the wave was actually sent round one way or the other. At quite short distances there was no record that the waves had come round the distant part of the earth other than the shortest distance between the transmitter and the receiver.

As to some recent experiments which had been carried out by a few workers associated with the Radio Research Board, there was a recent paper by Prof. Appleton and Mr. Barnett † in which they had measured the actual strength of the electric field and the magnetic field at the earth's surface. If the waves were propagated horizontally along the earth's surface, that electric field would be equal to the magnetic field; but in those experiments it had been found that the magnetic field at night, when variations of signal strength were going on, was greater than the electric field. That was considered to be a definite proof that waves were arriving at an angle of inclination to the earth's surface; but in some experiments of a similar nature carried out by Mr. Barfield and himself that had been confirmed to a very considerable degree ‡; that was, that the magnetic field was usually greater than the electric field, and he himself could see no other explanation of that than that the waves were definitely arriving at the earth's surface at an angle of incidence. In fact, from the result one could calculate the angles of incidence on which those waves were arriving.

Those were the difficulties which he saw in the way of accepting Mr. Taylor's theory, and he had drawn attention to what he thought was experimental proof that waves were being received from the upper atmosphere or the Heaviside Layer.

MR. J. HOLLINGWORTH said the author was to be congratulated on his moral courage in putting forward a view which was perhaps not being very favourably received at the present day.

With regard to the paper, he admitted he was not a sufficiently sound mathematical physicist to be able to criticise the physical idea of the transmission of waves along the earth's surface, but, like Dr. Smith-Rose, he had been engaged in certain experiments on that work recently, on quite different lines, and also like Dr. Smith-Rose he had started with an open mind and had come practically to the same views as those of Dr. Smith-Rose.

Mr. Taylor had made one or two points with which he could not quite agree. Might he suggest that Mr. Taylor had rather tested the results of to-day against the theories with regard to the 'layer' some years ago?

Mr. Taylor had laid a great deal of stress in several cases on what he called the optical analogy. That was a thing which must be treated very carefully, because all ordinary optical analogies depended on the assumption that we were more than a wave length from the reflecting surface, and that our interfering bodies were large compared with the wave length under consideration. In his own particular case, he had deliberately confined himself to wave lengths of the order of 12 kilometres. Therefore, unless he went into the Himalayas, he did not reckon he was likely to have mountains 12 kilometres high anywhere, and the little humps which one got in this country did not seem to be sufficient to produce enough effect for that purpose.

† Proc: Roy: Soc: A. Vol. 109, p. 621, 1925.

‡ Proc: Roy: Soc: A. March, 1926.

A great deal of controversy was at present arising on the explanation of the interference phenomena which, under various forms, had been detected by Dr. Smith-Rose and himself just recently. Mr. Taylor put forward explanations of that, the first one being the interference effects as the wave travelled over the surface of the earth. If they were caused simply by local diversions over mountains, and that sort of thing, it seemed that they must be very localised. He did not see how under those conditions they could follow any regular law. He had made some experiments last year in which he had mapped out the intensity from a station, and he had found that within the limits possible travelling in this country the intensity appeared to depend on the distance, but to be entirely independent of the direction in which he went. The actual case he was thinking of was the following. He had happened at intervals of quite a considerable period to have taken two observations on a transmitting station near Paris. One of those was taken on the top of Dartmoor and another was taken in the neighbourhood of Leicester. In those particular cases the distances were almost identical. The angles between them were 42°; one of them just across the Channel at about its shortest distance and then going entirely over land, and the other across the Channel at a larger angle and then over rather hilly country. Those signals were practically identical, and they were borne out by many other signals taken under the same conditions. The interference curve was a perfectly definite one. One would expect bumps and hollows if it was due to local effects, but there was no sign of that, and although he hoped to verify it this year he felt inclined to say that working on the reflection theory one could tell beforehand where one was going, to get the maxima and minima. If one could do it, it seemed to show that local conditions could not enter into the matter at all.

The other point was in connection with the sunset phenomena, which Mr. Taylor very definitely separated from the ordinary distribution phenomena. There, again, his own experience was exactly the reverse of Mr. Taylor's; in fact, he thought he could say definitely that if he were told the intensity which a certain station would give at a certain point in the middle of the day, he could state with a fairly high degree of accuracy what cycle that intensity would go through at that point at nightfall during the summer. During the summer there was a very definite connection between the intensity during the day and the particular behaviour that it went through during the evening. He had got out some curves recently in which he had taken a run on a certain station at three different places for the three hours covering the sunset period. The curves were of entirely different shapes.

(Mr. Hollingworth proceeded to illustrate the curves on the blackboard).

The important point was that he could foretell the actual shapes those curves were going to take from a knowledge of the readings taken in the middle of the day. They seemed to be definitely connected. Therefore he could hardly adopt the idea that the sunset effect was due to the wave having gone round the other side.

Mr. R. M. Wilmotte said Heaviside seemed to have had a very good evening, but he thought a certain amount of attention should have been given to Clark Maxwell. According to Clark Maxwell's theory, whenever there was any change conductor or dielectric a wave was sent out. The change need not be periodic. There was a pulse sent out. When one had an antenna, in the air, and one produced a pulse—if one charged it and then suddenly discharged it, a pulse was sent out which went out as a spherical wave in all directions. It was stopped by the earth because it could not go through, but above the earth it went round above the antenna. If one had a sine variation on that antenna one got a series of waves going away from the antenna in all directions. He understood that Mr. Taylor accepted the classical

equations, and accepted Poynting's theory of flux and the wave conduction along wires; in fact, he accepted all the classical theory of electricity. He could not see how Mr. Taylor could help coming to the conclusion, to which most people had come, that waves were actually sent out in the ether or in space whenever a change of electric force took place. When a wave was conducted between two conductors, which were many wave lengths apart, (as was the case between the earth and an aerial at a large distance from it) it spread from one conductor to the other in the form of a wave travelling in straight lines in all directions. Should this wave meet a large conductor, this conductor shielded the space behind it from the approaching wave. He himself failed to see how, according to Mr. Taylor, the earth near the antenna did not shield places at the antipodes. Did Mr. Taylor consider that the wave held on to the antenna? If so, he must renounce the classical theory and all the evidence in its support.

THE CHAIRMAN then read the following letter from Prof. E. V. Appleton :—

"I very much regret the position Mr. Taylor has taken up. It seems to me that he wishes us to take a step backwards. Mathematicians have examined how much the waves of wireless telegraphy are conducted by the ground round the protuberance of the earth, and, even if the most favourable conditions are assumed, diffractive bending is shown not to be enough to account for the observed signal intensities. There must be some other favourable influence.

Mr. Taylor quotes the analogy of waves on wires, but there, to get proper guiding of the waves, we require two conductors, i.e., two wires, or one wire and the earth. In the wireless problem the two conductors are the earth and the ionized atmospheric layer. But Mr. Taylor is frankly sceptical about the rôle played by the Kennelly-Heaviside layer in wireless propagation. In a series of papers Mr. Barnett and I have described a direct experimental proof of the existence of this layer. These experiments have also given us the height of the layer and the number of electrons per c.c. in it. The experimental proof of the existence of the layer is in two parts. In the first place, by changing the wave-length of the Bournemouth B.B.C. transmitter continuously through a small range interference maxima and minima were obtained at a receiving station at Oxford. This experiment proved the existence of at least two rays. More recent experiments carried out by Mr. Hollingworth for the Radio Research Board have fully confirmed these conclusions. But these experiments did not *prove* that the interfering rays came down from the upper atmosphere. To complete the proof, it was shown at Cambridge that the signal variations on a loop aerial are greater than those on a vertical aerial at the same place, which can only be the case if rays arrive at the receiver in a downward direction. These experiments have shown that at distances greater than about 150 miles from a broadcasting station the main signal is due to the rays deviated by the atmosphere, the ground ray being relatively negligible.

The amount of bending round the earth for the ground ray on short wave lengths has been examined by Mr. Barnett and Mr. Ratcliffe at Cambridge, and, as was expected, has been found to be negligible. For the long distance transmission of such waves (which has been so successfully demonstrated by wireless amateurs and the Marconi Company), we must therefore hold the ionized layer wholly responsible.

MR. TAYLOR, in reply, said he was sorry to say that he had not found anything new against his theory in any of the points which had been raised in the discussion. Dr. Smith-Rose had referred to the very small degree of tilt. His (Mr. Taylor's) point was that so long as there was a semblance of tilt to the surface on which the wave was travelling, that determined guidance by that surface.

He knew that his ideas were new to Dr. Smith-Rose and to many others, and it was necessary for ideas to soak in before they were realised.

With regard to reflection from obstacles, Dr. Smith-Rose had referred to the reflection from the hill of Howth. That was the very thing he had wanted to avoid. He had said in the 1905 paper that apparently the humps were due to reflection from the hill of Howth, but he did not take it at all definitely; he was very much in doubt as to what caused the shape of the other curves, and as to what caused the irregularities on the distant end of those curves, which could not be due to reflection. He was not now trying to explain those humps by reflection from the hill of Howth, but by reflection of the medium itself—by that reflection which one got in a telephone cable which was not loaded. When one attempted to transmit telephone currents along it one got the speech thrown back into one's face from the telephone cable. In the same way, if one got reaction from those waves one got parts of the waves reflected back towards the transmitter. That was the point.

Dr. Smith-Rose had also raised points about other matters which he had said in his paper he could not deal with, as this would unduly extend the length of the address, but he hoped to let Dr. Smith-Rose have some explanation.

Mr. Hollingworth had protested against his bringing in and criticising theories which were very ancient. Mr. Hollingworth must not forget that one of the points which he (Mr. Taylor) was stressing was that he had given the guided wave view 27 years ago, and it had never been satisfactorily disposed of.

Mr. Hollingworth had queried whether hills were sufficient to produce optical shadows, and had pointed out that he was on dangerous ground. He was quite aware of that. If Mr. Hollingworth would take waves 60 metres long being used on the earth, and reduced the whole system of 60 metre waves, plus the earth, down to a sphere the size of one centimetre diameter, he would find he would then get yellow rays of light. If one had a model of the earth with its hills and mountains, one centimetre in diameter, and illuminated that with yellow rays of light, and looked at it under a microscope, were not those mountains going to cast shadows? His point was that the mountains would cast optical shadows. That being so, it showed that where one had rectilinear propagation shadows were obtained. If shadows were not present, then the propagation was not rectilinear.

He must be pardoned if he did not reply in detail to all the questions which had been raised against his paper, but they would be dealt with in the course of time. He fully upheld the views which he had put forward in the paper, and he did hope that the members of the audience would let them soak in. He had had to go into fundamentals because that was where he thought the fault lay.

A hearty vote of thanks to Mr. Taylor concluded the meeting.

In further reply to the discussion Mr. J. E. Taylor writes: –

There are two points which appear to have been specially stressed as telling against the guided wave view. In the first place it is stated quite definitely that mathematical proof has been given that waves cannot be guided over the surface of the earth for more than a limited distance. As I understand the mathematical proof it relates purely to the diffraction view and assumes rectilinear propagation. Consequently the position I take up in regard to this proof is that it is based on erroneous premises and is therefore invalid. The other point is that proof has been given of the reception of waves of variable intensity in a downward direction. My contention here is that, while I do not object to the proof that such variable rays are received, there are other possible explanations. One of these explanations has reference to the fact that so long ago as 1915 Marconi pointed out that the variation in signal

intensity across the Atlantic had been found to be, to a large extent, local to the transmitter (see discussion on Professor Marchant's paper Journal of the I.E.E., Vol. 53, pp. 329 *et seq*). I suggest that what has more recently been found in regard to downward rays is an effect of the same nature and due to the same cause. That cause is probably connected with the atmospheric electric stress or normal potential gradient which extends upwards from the antenna into the more or less ionised parts of the atmosphere. In these parts the electric stress or gradient is probably very inconstant, consequent on variable ionisation. Impressed on this variable gradient above the transmitter are electrical oscillations due to the alternating charges on the antenna below. As a result there no doubt exists what I have termed a "high level component" of the main wave which is likely to be very variable in character. Such a high level component would give out rays which would reach the earth in a downward direction and should be chiefly evident in regions not too far removed from the transmitter, where it might well give rise to fading effects.

So far as diversion of the wave rays by free ions or electrons is concerned, even if this were possible to a sufficient extent to pour back a considerable part of the total emitted radiation, I fear it has been overlooked that the normal atmospheric stress should exert forces on these ions or electrons far greater than the attenuated field of the radiated waves could exert and would, therefore, hold them in strong control. Moreover, the normal potential gradient is in a state of ceaseless turbulence and change so that it can hardly be argued that the alternating nature of the wave field would enable it to superpose its effect on the electrons. Yet again, regard must be paid to the widespread prevalence of thunderstorm fields throughout the atmosphere, during which electric stresses are generated of far greater magnitude than the normal potential gradient stresses. The influence of such thunderstorm fields must be very far flung. In the face of such conditions it seems perfectly clear that any free electrons which might, conceivably, be available to the wave field in other circumstances, will be so gripped by these far more powerful forces as to be absolutely beyond the control of any such feeble forces.

As regards the argument that wave guidance only holds when two conductors take part I confess I have not previously had this contention seriously put against the guided wave view and I am afraid I cannot take it seriously. When two conductors are concerned there must be some property of each conductor which determines concentration of the wave field about the conductor; in other words guidance of the wave. That property of the conductor must surely exist when either conductor is considered separately. In the case of a wave travelling along a single conductor, for each complete half wave two parts of the same conductor are concerned and the electrical system is thus not essentially different from the case of two separate conductors. To deny guidance in the case of a single conductor is, I think, illogical.

On the question of wave tilt Dr. Smith-Rose states that if the matter is looked into more carefully it will be seen that the forward tilt does not decrease but increases the velocity of propagation along the earth's surface. Now if Dr. Smith-Rose will look into this still more carefully he will find my statement is correct. Suppose the propagation concerned is that of a stream of particles forming a beam. Consider the propagation of any one particle in the beam in relation to an inclined surface across the beam. The trajectory of the particle will be along the hypotenuse of a right-angled triangle the base of which lies on the inclined surface. The distance traversed in the direction of the inclined surface will thus be less than that taken along the hypotenuse and the velocity of the particle therefore less, being, in

fact, proportional to the cosine of the angle at which the particle meets the inclined surface. Clearly a particle can have no velocity in a direction at right angles to its trajectory; otherwise a beam of radiation could not exist.

I do not think Mr. Hollingworth has made his point very effectively in regard to the sunset effect. Presumably his prediction of the nightfall variation of signal intensity is based on interference between two waves traversing paths of different length. If so, the same factors would operate on my view but the difference in length of paths would arise from one path being taken around the globe. It would seem that if a prediction can be made it should apply equally on my view. Some measurements with limited wave trains without a continuous carrier wave appear to be wanted to decide the matter definitely.

A point which I am endeavouring to establish is that transmission of waves over and around the earth's surface resolves itself into the preliminary stages of establishment of stationary waves on the earth in a similar manner to the establishment of harmonic oscillations on a wireless antenna. With long waves the stage it is possible to reach is limited by reason of the heavy damping losses, mainly occurring in the higher regions of the atmosphere. With short waves the establishment of the stationary condition proceeds to a much fuller stage of development because the damping losses are greatly reduced, very little of the wave energy reaching the higher defective parts of the atmosphere because these waves cling closer to the earth's surface. Other difficulties will, however, present themselves in dealing with short waves but these should not be insuperable.

The discussion on this paper seems to have made it clearer than ever that there is a sharp line of demarcation between Heaviside's theoretical views and the academic views of the day. Personally, I prefer Heaviside's views.

OBITUARY.

Captain Sir H. Acton Blake, K.C.M.G., K.C.V.O.—Sir Acton Blake died suddenly at sea on March 7th, while on a voyage to South Africa. He had recently undergone a severe operation from which, however, he appeared to be making a good recovery.

Born in 1857, he entered the merchant service, and rose to command ships of the British India Steam Navigation Company and the African Royal Mail Company. He was also a Captain in the Royal Naval Reserve. In 1901 he was appointed an Elder Brother of the Trinity House, of which he became Deputy Master in 1910. He represented Trinity House on the Port of London Authority, served on the Departmental Committees on the Mercantile Marine and on Tonnage, was Chairman of the Board of Trade Advisory Committee on Pilotage and of the Dock and Harbour Dues Claims Commission, and was a British Delegate on the International Committee for Safety of Life at Sea. In recognition of his public services he was created K.C.V.O. in 1914 and K.C.M.G. in 1918.

Sir Acton Blake became a Fellow of the Royal Society of Arts in 1924, and shortly afterwards was elected a Vice-President. At this time, under the will of the late Thomas L. Gray, the Society was appointed residuary legatee of the testator's estate for the purpose of establishing a memorial of his father, Thomas Gray, C.B., Head of the Marine Department of the Board of Trade, the main object of the bequest being "the advancement of the science of Navigation and the scientific and educational interests of the British Mercantile Marine." A committee was appointed to advise the Council with regard to the administration of this trust, and Sir Acton was appointed chairman. He took a very warm interest in the matter and his profound knowledge of the Mercantile Marine rendered him peculiarly able to advise

the Council as to the best methods by which they could carry out the objects of the trust. The loss of his expert advice, both in connection with the Thomas Gray Memorial Trust and in relation to the general work of the Council, will be very keenly felt.

EDWARD PENTON.—Mr. Edward Penton, who had been a Fellow of the Royal Society of Arts since 1897, died at his residence in Cavendish Square on March 5th at the age of 80. He founded what is now the great leather firm of Edward Penton and Son in Mortimer Street and Newman Street. At the outbreak of the Great War he had retired from business, but he returned to work in order that he might leave his son, Sir Edward Penton, free to discharge his duties as Superintendent of the Boot Section of the Royal Army Clothing Department.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 22..Chadwick Public Lectures, at the Museum, Maidstone. 7 p.m. Sir Wilfred Beveridge, "Insects in Relation to Public Health."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Mr. G. Rogers, "The Performance of Mercury Arc Rectifiers."

At the Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. L. C. Grant, "Developments in High-Power Fusible Cut-Outs."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Dr. Hamilton Rice, "The Rio Branco."

Société Internationale de Philologie, Sciences et Beaux Arts, 8, Taviton Street, W.C. 3.30 p.m. Mr. David Freedman, "The Zohar The Book of Splendour."

TUESDAY, MARCH 23..Asiatic Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.30 p.m. Dr. H. R. Hall, "Mesopotamian Archæology."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. J. W. J. Townley, "The Operation of a Modern Power Station."

At University College, Nottingham. 6.15 p.m. Messrs. C. C. Sutton and J. H. H. Nixon, "Power Factor."

London Society, at the Royal Academy, Piccadilly, W. 4.30 p.m. Annual General Meeting.

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. D. Brownlie, "Super-Pressure Steam Generation."

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Annual General Meeting and conclusion of discussion on Dr. Wade's paper, "The Search for Oil in Australia."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. C. H. Desch, "The Growth of Crystals." (Lecture II.)

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. "Charlotte Bronte."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. Bertram Park, "A Glimpse of Corsica."

WEDNESDAY, MARCH 24..Geological Society, Burlington House, W. 5.30 p.m. Sir T. W. Edgeworth David "The Physiography and Tectonic Structure of the Commonwealth of Australia."

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. "The Use of the Microscope as a Measuring Instrument."

Naval Architects, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 11 a.m. Mr. A. C. F. Henderson, "The Present Outlook for British Shipbuilding." Mr. W. J. Berry, "Launching Arrangements of H.M.SS. 'Nelson' and 'Rodney.'"

Hygiene, Institute of, 28, Portland Place, W. 3.30 p.m. Lieut.-Colonel Dr. R. H. Elliot, "Eye Troubles of School Life."

THURSDAY, MARCH 25..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

China Society, at the School of Oriental Studies, Finsbury Circus, E.C. 5 p.m. Dr. Lionel Giles, "First-Fruits from Tunhuang."

L.C.C., Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. E. J. Warne, "Decorating and Furnishing a Room."

Naval Architects, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 11 a.m. to 8 p.m. Mr. Robert Sulzer, "Temperature Variation and Heat Stresses in Diesel Engines." Mr. W. J. Lovett, "Comparative Freight Economics of a Cargo Vessel with Reciprocating and with Diesel Machinery." Prof. C. M. Carter, "Propeller Dimension Formulæ based on Mr. R. E. Froude's Model Screw Experiments" Mr. W. G. A. Perring, "Some Experiments upon the Skin Friction of Smooth Surfaces." Mr. J. L. Kent, "Experiments on Mercantile Ship Models in Waves." Mr. W. C. S. Wigley, "Ship Wave Resistance. A Comparison of Mathematical Theory with Experimental Results."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Holland Rose, "The Indecisiveness of Modern Warfare." (Lecture II.)

Royal Society, Burlington House, W. 4.30 p.m.

Victoria and Albert Museum, South Kensington, S.W. 6 p.m. Mr. A. J. B. Wace, "English Domestic Embroideries."

Chemical Society, at the University, Manchester. 4 p.m. Annual General Meeting. Dr. Arthur W. Crossley, Presidential Address.

FRIDAY, MARCH 26..Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Mr. Summers Hunter, "'Perlit' Iron."

Naval Architects, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 11 a.m. to 3 p.m. Mr. Harold E. Yarrow, "High Pressure Water-Tube Boilers for marine Purposes." Eng.-Capt. L. M. Hobbs, R.N., "Some Recent Modifications to Water-Tube Boilers of the Three-Drum Type Fitted in H.M. Navy." Mr. A. W. Cluett, "On the Method used in H.M. Ships for Readily Correcting Heel and Trim." Mr. Ebenezer Smith, "Crane Equipment of Shipbuilding Berths."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. John MacSymon, "A Criticism of the 1925 Competition Prints."

Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m. Mr. I. Backhurst, "Obliquity Corrections in Radium Estimation." Prof. Dr. A. Griffiths and Mr. P. C. Vincent, "The Viscosity of Water at Low Rates of Flow, determined comparatively by a method of Thermal Convection." Dr. E. H. Rayner, Demonstration of Some Simple Experiments with Thermionic Valves.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir Ernest Rutherford, "The Radiation from Atomic Nuclei."

Transport, Institute of, at the Midland Hotel, Manchester. 6.30 p.m. Mr. R. Bell, "One hundred years of Railway Development."

SATURDAY, MARCH 27..L.C.C. Horniman Museum, Forest Hill, S.E. 3.30 p.m. Dr. H. S. Harrison, "Early Man and his Wanderings."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Ernest Rutherford, "The Rare Gases of the Atmosphere." (Lecture IV.

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FRIDAY, MARCH 26th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, MARCH 29th, at 8 p.m. (Cantor Lecture). W. F. HIGGINS, M.Sc., Principal Assistant, National Physical Laboratory, Teddington, "Thermometry." (Lecture III).

FOURTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 17th, 1926. In the absence of the RIGHT HON. VISCOUNT CECIL OF CHELWOOD, P.C., K.C., LL.D., who was unavoidably detained at Geneva, the Chair was taken by SIR RICHARD REDMAYNE, K.C.B.

The following candidates were proposed for election as Fellows of the Society:—

Chettiar, M. K. P. M. Chidambaram, Ramachendrapuram, Pudukotah State, India.
Dunsmore, Major R. L., B.A.Sc., Talara, Peru, South America.
Hakim, R. S. Dewan Rattan Chand, Quetta, Baluchistan, India.
Thompson, Fred, Keighley, Yorks.

The following candidates were duly elected Fellows of the Society:—

Chatterjee, Devendra Nath, B.A., B.Sc., Agra, India.
Gleave, W. H., Formby, Lancs.
MacKrow, Claude V., M.I.N.A., London.
Mersh, Charles Melmoth Bailey, M.I.E.E., Nagpur, India.
Mohanty, S., Cuttack, India.
Serner, Dr. Herbert E., Buffalo, N.Y., U.S.A.
Williams, Richard Albert Basil, London.

A paper on "Co-Partnership" was read by LIEUTENENT-COLONEL JOHN HERBERT BORASTON, C.B., O.B.E.

The paper and discussion will be published in the *Journal* dated April 30th.

CANTOR LECTURE.

MONDAY, MARCH 22nd, 1926. MR. W. F. HIGGINS, M.Sc., Principal Assistant, National Physical Laboratory, Teddington, delivered the second of his course of three lectures on "Thermometry."

The Lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, 19TH FEBRUARY, 1926,

THE RT. HON. THE EARL OF RONALDSHAY, G.C.S.I., G.C.I.E., in the Chair,

THE CHAIRMAN said that to introduce Sir Michael O'Dwyer to an audience of ladies and gentlemen interested in India was surely a work of supererogation. Sir Michael in his earlier years graduated at Oxford from Balliol College, that famous College which, under the late Dr. Jowett in the 'seventies and early 'eighties of the last century, became so famous a nursery of public men. All those who had followed Sir Michael O'Dwyer's career or who were familiar with the recently published record of his time in India would be well aware to what good purpose he put the 35 years which he spent in that Continent, mostly in the Punjab. The Royal Society of Arts had recognised the qualifications which Sir Michael possessed for speaking on Indian problems other than those of a purely administrative character by inviting him to come that afternoon and give the Sir George Birdwood Memorial Lecture, and most of the audience would agree, he thought, that Sir Michael could hardly have chosen a more interesting subject for a lecture than the one which he had selected, namely, "Races and Religions in the Punjab," for the reason, if for no other, that not for centuries only but for millenia the Punjab had been the gateway of India, through which had passed into that Continent the many and diverse races which went to make up its population at the present day. It was therefore clear that the meeting could look forward to a paper of extreme interest.

The following paper was then read :—

RACES AND RELIGIONS IN THE PUNJAB.

By SIR MICHAEL F. O'DWYER, G.C.I.E., K.C.S.I., formerly Lieutenant-Governor of the Punjab.

In exercising the discretion kindly allowed me by the Royal Society of Arts when they honoured me with the invitation to deliver the Birdwood Memorial Lecture, I have selected as my theme the "Races and Religions of the Punjab." And however inadequately I may deal with that difficult but fascinating subject, I feel that it is one which would have especially appealed to that brilliant student of everything Indian, Sir George Birdwood. For the Punjab was the corridor through which nearly all the Eastern races, from the Vedic Aryans

forty centuries ago to the Semitic Afghans of to-day, who have affected Indian history and culture, entered the peninsula; and if their footprints are no longer clearly visible their influence is more perceptible in the Punjab than elsewhere in India. Coming to religions, the beautiful hymns of the early Vedas were first heard in its plains; it was the centre from which the Buddhist religion and culture spread over the East from Khorasan to Cathay; it witnessed the reaction by which militant Brahmanism after an eclipse of nearly ten centuries re-established its ascendancy by vanquishing Buddhist quietism; it gave passage to the Musalman invaders from the West—Arab, Persian, Turk, Afghan, Mughal—who from the 7th to the 18th century extended their rule and propagated their creed over the Indian races often by fire and sword; in the 15th century, while still the borderland between an aggressive Islam and a Hinduism overloaded by ritual, it evolved a compromise between the two in the simple Sikh Monotheism of the broad-minded Nanak; two hundred years later it saw that kindly creed, under the stimulus of Mughal persecution and Brahmin social ostracism, converted by the later Gurus into the military theocracy of the Khalsa, which established Sikh rule over the land of the five rivers; finally, in the 80 years of British rule the Punjab has given birth in Hinduism to the latest serious challenge to Brahmin supremacy in the Arya Samaj, with its repudiation of idol worship and its cry of "back to the Vedas," and in Islam to a similar revolt against tradition in the Ahmadiya cult, which seeks to bring Islam into line with the other great religions, and in particular repudiates the doctrine of Jihad or propagation of the faith by the sword.

I have not the time nor the knowledge to discuss those great racial and religious movements which have left their mark on the Punjab of to-day. I shall limit myself to sketching roughly some few of their outstanding features, and particularly those which distinguish the Punjab from other parts of India, in which the aboriginal Dravidian and Mongoloid strains have been less affected by the Indo-Aryan, Iranian and later Aryan waves of immigration and conquest.

Permanence of Racial or Inherited Characteristics.

"All men are born equal, all men are born free"—I doubt if any ten words ever contained more profound ignorance or more dangerous fallacies than these. However admirable as a social ideal they may have appeared to the French philosophers of the 18th century who first enunciated them; however useful they may have been as political catchwords to the American statesmen who placed them in the forefront of their Declaration of Independence; they were then and are still completely at variance with the facts in every part of the known world. And nowhere is their absurdity more obvious than in India, where, under the system of caste, not only is a man born into a particular status governing all his social relations during life, but he cannot, except very rarely by pious fraud or legal fiction, emancipate himself in this life from the social compartment into which he was born.

Even after the high-sounding formula I have quoted fell into discredit, the theory that men were born much alike and that their development depended mainly on the physical and social conditions—including religion and civil institutions—which surrounded them, held the field. It was a plausible but shallow theory, which in its day, and its day is not yet quite past, has been responsible for much loose thinking and much ill-directed and therefore futile or mischievous policy and legislation. But we are steadily approaching the light. To-day as the result of scientific investigations all over the known world, in which American scientists such as MacLennan and Stoddard have borne a prominent part, we know that human qualities are inborn, that environment can develop the latent inherited faculties but not seriously alter them, and that heredity or race is the most vital and determining factor in human beings.

The individuals in a race or common stock may and do differ widely from one another, but to quote Stoddard's "Racial Realities,"

"They inherit certain physical, mental and moral traits which together form a generalised race-type that descends from generation to generation, persists under all sorts of surroundings and determines more than anything else what sort of persons the members of the race will be, how they will act, and what they will do."

Illustrations from the Punjab—Pathan and Biluch.

Those of you who have lived in the Punjab and studied its peoples will at once recall to mind many instances of the truth of the above quotation. The classic illustration which leaps to my mind is that of the two great Islamic races on the western border of the province, the Biluch and Pathan, and at the risk of anticipating my main argument, I will pursue this instance now.

These two races come undoubtedly from different stocks; the Biluch from an Arab source, the Pathan from a mixture of Indian and Afghan (Semitic) strains. Both have lived for at least twelve centuries in the same environment —a nomadic or semi-nomadic life among the barren hills and the occasional watered valleys of the great mountain range that separates the Indus valley from Afghanistan and Persia; both have been Muhammadans of the Sunni persuasion for over 1,000 years, and they have necessarily many common qualities. But mark the radical racial differences which no uniformity of conditions has been able to eradicate.

Ibbetson has summed up these characteristics in a few brilliant sentences.

"Both have most of the virtues and many of the vices peculiar to a wild and semi-civilised type. To both hospitality is a sacred duty and the safety of a guest inviolable; both look upon the exaction of blood for blood as the first duty of man; both follow strictly a code of honour of their own, though one very different from that of modern Europe; both believe in one God whose name is Allah and whose prophet is Muhammad. But the one attacks his enemy from in front, the other from behind; the one is bound by his promise, the other by his interest; in short

the Biluch is less turbulent, less treacherous, less blood-thirsty and less fanatical than the Pathan. He has less of God in his creed and less of the devil in his nature."

The justice of this description will strike anyone who has come in contact with the two races living almost side by side in their own hills; compare for instance, the Wazir and Mahsud of Waziristan with the Biluch of the Derajat and its hinterland. But the difference goes even further. The Biluch and Pathan both have a strong tribal organisation. The Biluch system is markedly feudal, and the tribesman gives willing obedience to his tribal chief, in whom indeed he has such confidence that certain tribes are glad to leave to their chief the privilege of keeping the Ramzan fast and saying the daily prayers for the whole tribe!

The Pathan on the other hand is intensely democratic. I found some 20 years ago certain tribes in the Swat valley and one in Bannu within our border which adhered to the archaic system of periodic redistribution of the tribal land, to prevent profiteering and maintain equality. In one case all the males, in another all the " mouths " of the tribe, including the infant in the womb, received an equal share. But all had got tired of this system and decided to abandon it. The Pathan chief, where there is one, may get an extra share in the tribal land but has little power except to lead his tribe in war; the tribesman only bows to the decision of the tribal council or Jirga, and then only where he knows it will be enforced by the dagger or the rifle. In religious and social matters the Pathan displays some of the fanaticism and retains some of the customs of that ancient Israel from whose lost tribes he claims descent. Of these the most notable are the periodic redistribution of land already referred to, the sacrifice of animals and smearing the doorway with their blood to avert evil, and the stoning to death of heretics. These practices have almost disappeared where the Pathans have come under the softening influence of British-Indian civilisation. But they still prevail outside that influence, and only last year three members of the quietist Ahmadiya sect, which in the Punjab is most loyal and law-abiding, were stoned to death in Kabul for heresy under the order of an ecclesiastical Court confirmed by His Majesty the Amir.

Pathan and Biluch Humour.

Pathan and Biluch alike have a strong sense of humour, and even carry this to the extent of saying hard but witty things at their own expense as well as their neighbour's. The Biluch will laughingly tell you that he is a born thief, and to prove it will quote his tribal proverbs :—

" God will not favour a Biluch who does not steal and rob ";

" The successful thief secures heaven to seven generations of ancestors."

The fact that he is known, at least to-day, to be frank and honest gives zest to the exaggeration. The Pathan's self-analysis is more grim and nearer the truth :—

" A Pathan's enmity smoulders like a dung fire but never dies ";

"Keep a cousin poor; when he is little, play with him; when he is grown up, he is a cousin, fight him";

"Speak good words to an enemy very softly; destroy him gradually to the very root";

"The Pathan eats his enemy, the Hindu his friend."

The contemptuous attitude of the more settled and civilised Pathan living under British rule to his wild semi-nomadic brethren in the adjoining hills is well illustrated in the following:—

"Burrs are not grass, nor is a hillman a human being."

At the risk of irrelevancy, I will cite two instances of Pathan and Biluch ready wit from my own experience. Our good friend, the late Amir Habibullah of Afghanistan, who was murdered in February, 1919, was dining at Government House, Peshawar, in the spring of 1907, on his first and only visit to India. The Afghans, like all hillmen, are very fond of the bagpipes, and the splendid pipers of the Black Watch were called in to play during the dinner. They were sixteen in number and rose nobly to the occasion. When the loyal toasts were being proposed, they formed up behind the Amir's chair and almost raised the roof by the vigour of their performance. Then they slowly filed out, and, as the strains of their melody died away, the host (Sir Harold Deane) turning to his guest said, "I hope your Highness liked the pipes, we are very proud of them." The Amir replied, "Splendid, magnificent," and added with a twinkle in his eye, "One would have been sufficient."

The Biluchis are gallant horsemen and passionately fond of horses, or rather mares, and being devoted to the breeding of horses and camels, pride themselves on being excellent judges of breed and quality.

The late Nawàb Sir Bahram Khan, the leading Biluch chief, was giving evidence at Lahore in 1912 before the Royal Commission on the recruitment for the services in India. He laid special stress on the need of selecting candidates of good stock. One of the members, who was then and is still a distinguished Parliamentary representative of the Labour Party, asked him how he could distinguish whether a candidate was well-bred or ill-bred. The old chief snorted and replied with some warmth, "We Baluchis know all there is to know of the qualities and breeding of a horse or a camel. Do you think we can't judge whether a man comes of a good stock or an inferior one?"

Blend of Races in the Punjab.

From this digression regarding the races on the Western fringe of the Punjab I now turn to the races within the province.

Here we are on much less firm ground. There is no regular history of the Punjab prior to the Muhammadan invasions. But we know that for at least two thousand years before that era there were mighty movements of the people north and west of the Himalayas into the Punjab and India. Wave after wave of conquest and migration broke through the Western passes leading

into the Punjab and swept over its broad surface ; sometimes spending themselves there, sometimes receding towards their source, sometimes penetrating, though in steadily diminishing volume, into the valley of the Ganges and Central and Southern India, and in their course exterminating, or driving back, or slowly amalgamating with, the aboriginal races. The result of all these movements is that the distinctions of race, speech, culture and even religion became overlaid and confused. One of the most fascinating studies for the historian and the archæologist of to-day is to unearth and analyse the various layers in which the vestiges of these ancient races and their cultures are embedded. Perhaps the most brilliant example of how this can be successfully accomplished is to be found in Sir John Marshall's wonderful excavations on the site of the ancient Taxila close to Rawal Pindi, where no less than five successive races superimposed their arts and their culture on those of their predecessors between the 4th century B.C. and the 5th century A.D.

First Aryan Invasion.

The first great migration or conquest of which we have any knowledge is the Aryan invasion some 4,000 years ago. The Aryans were of that sturdy Nordic stock, which though lacking the artistic and imaginative gifts of the softer Dravidian races whom they conquered and despised as inferior mortals, had in a high degree the more practical qualities of virility, enterprise and organisation. The possession of similar qualities by most of the Punjab races to-day is doubtless due to the admitted fact that the Aryan element is much stronger in the Punjab than in any other part of India.

As Stoddard points out :—

"Nothing better illustrates the persistence of race qualities than the way in "which the Nordics have everywhere shown the same striking traits. . . . . .

"The Nordic prides himself on his race and seeks to guard the purity of his "blood. Look at the Aryan invaders of India as described in the old Sanskrit "Scriptures. Those first Nordics to appear on the stage of history entered India "nearly 4,000 years ago. Yet the family likeness to other Nordic races is un-"mistakeable. Tall, fair, hard-fighting, yet jovial, loving good food, drink, fresh air "and exercise ; chivalrous towards their women ; despising the little dark negroids "as monkeys and setting up a rigid colour line—how like our Anglo-Saxon pioneer."

The last remark recalls to me an incident in Central India some 13 years ago. I was discussing with a Punjab Brahmin the racial characteristics of the peoples south of the Nerbudda, and remarked that, admirable as they were in many respects, in manner and bearing they fall short of the standards of Northern India. My Brahmin friend interrupted, "But Sir, that is a trite saying. We know from the Shastras that manners and men stop short at the Nerbudda. South of that you find the Rakhshashas (demons) and the aboriginal dark-skinned races (Dravidians) whom our ancestors conquered and despised." He was expressing feelings, prejudices if you will, which are common to most Punjabis. The Pathan and the Muhammadan

Rajputs of the north and the Sikhs of the Central Punjab who went down to fight against the rebels in Hindustan and Central India in 1857-58, and their descendants to-day habitually speak of the Sepoy Mutiny as the "rising of the blacks" (Kaliyan ki Shorish), though many of the mutineers came of Rajput stock.

However much we may deprecate this racial arrogance, we cannot ignore it, especially in India; for it is the very basis of the caste system (Varnashram) which had its origin in the colour line. The Rig Veda, which was composed in the Punjab, recognises four classes of men, the Brahmins or priests and learned men, the Kshatriyas or warriors and rulers; the Vaisyas or traders and agriculturists, the Sudras or menial and servile class. The division was primarily by occupation; the first three classes were the fair-skinned Aryans, the fourth the dark-skinned aborigines. In course of time, under Brahmin influence, this division came to be recognised as hereditary. The caste system was given a divine origin by the Brahmins, who represented the Brahmins as coming from the mouth of the creator, Brahma, the Kshatriyas from his arms, the Vaisyas from his thighs, the Sudras from his feet. This conception of hereditary castes which was consolidated in the code of Manu was gradually evolved during and after the Vedic period by the Aryan immigrants as a means of keeping their stock pure and free from admixture with the Dravidian, Mongolian and other aboriginals who would otherwise have swamped or absorbed them. The great Hindu epics of the Ramayan and Mahabharata deal largely with the conflict of races. The scene of the Ramayan is mainly in Oudh and the Ganges valley, where the Aryan immigrants had by then penetrated from the Punjab; but the present cities of Lahore and Kasur are referred to as founded by Lava and Kusa the two sons of Rama. The final struggle between the Kauravas and the Pandavas described with true Homeric vigour in the Mahabharata, took place at Kurukshetra near Panipat where the dominion of India has so often been lost and won. It is a significant fact that the northern invaders have always won, because the mixed Indian forces, whether Rajput, Mughal or Mahratta lacked not courage, but cohesion, for there was no national unity and no national resistance.

Subsequent Invasions by Aryan or Scythian Races.

After the Aryans the next invasion we know of is that of the Persians, also an Aryan race, under Darius in 512 B.C., when the Buddhist revolt against Brahmanism and caste, which had by then become a fixed hereditary system, was beginning to spread over northern India. Part at least of the Punjab formed the twentieth and most eastern satrapy of the Persian empire for a generation. When Alexander of Macedon overwhelmed that empire 200 years later, he too extended his victorious arms into the North and Central Punjab, where Taxila was already a flourishing university, and reduced its Aryan Rajput princes to submission in 327-6 B.C. His name is still a household word in the

Western Punjab and a favourite Muhammadan patronymic in the form of Secunder. Some 35 years ago the chief of one of the nomad tribes of the desert tract between the Chenab (Hyphasis) and the Ravi (Hydraotes)—which the Chenab Canal has now converted into one of the richest agricultural districts in the world—took me over the ruins of Sangla Fort, and showed me the spot where Alexander is supposed to have been wounded in the eye by an arrow from the garrison. There is a well established tradition that Alexander's march from the north Punjab down to Scinde and the sea-coast can still be traced by the date groves that sprang up where his armies encamped; for the date was their chief commissariat, as it is that of the desert Arab to-day. A few years later, Alexander's lieutenant Seleucus was expelled from the Punjab and Afghanistan by Chandra Gupta who founded the famous Maurya dynasty, with its head quarters at Pataliputra, the present Patna. His grandson, the great emperor Asoka, came to the throne in 269 B.C., ruled over most of India, made Buddhism the State religion and sent his missionaries to spread the new gospel over all the surrounding countries. His edicts carved on stone are still to be found in the remotest corners of the Province and of the north-west frontier, bearing witness to the strength of the central power, and the benevolent, if pessimistic and pantheistic, principles of the new creed. About 200 B.C. the Greeks or Greco-Bactrians from the north-west again pushed into the north Punjab and established a Hellenistic kingdom under the kings Euthydemus, Demetrius and Menander, whose gold and silver coins are still often found in excavating ancient ruins. After 100 years or so this dynasty was displaced by the Parthians, who had a flourishing capital at Taxila. They soon gave way to the Kushans, a Scythian race of Aryan stock from the north-west, of whom Kanishka or Kanerk was the best known king, and they held sway in the north-west Punjab for some centuries. Then, they in their turn were ousted in the 5th century A.D. by a race known as the White Huns, who under their kings Toramana and Mihirakula made Sialkot their capital. About this time the foreign invasions from the north-west ceased, and the great Gupta dynasty established for a few centuries an Indian Empire almost as wide as that of Asoka 500 years before.

The northern invaders had either been Buddhist or rapidly came under Buddhist influence, and from the Greco-Bactrians to the White Huns we find in the Punjab art and culture a singular but marked combination of Hellenism and Buddhism, associated primarily with Gandhara (now Peshawar). and Taxila.

But from the 6th century Buddhism steadily lost ground, not only in the Punjab but throughout India, and as the foreign invasions ceased, we find various Hindu Rajput dynasties from the south, the Tomars of Kanauj, the Chauhans from Ajmer, gradually extending their sway north into the Punjab. This Hindu reaction was strongly supported by the Brahmins, and the most potent means of encouraging it was the admission of the various later conquering tribes to a high place in the Hindu social organisation as

Rajputs (sons of rulers) or Kshatriyas. It would be interesting to speculate what would have been the results of this absorption if the process had not been rudely interrupted by the Muhammadan invasions which began in the tenth century. But it is important to remember that from the first Aryan penetration down to the 10th century all the invading races, as far as we know, were of pure Aryan stock. That accounts for the prevalence of the Aryan type in the Punjab to-day.

Muhammadan Invasions—Semitic and Mongol Races.

With the Muhammadan invasions covering some seven and a half centuries we get an influx of mixed peoples, Arabs, Persians, Afghans, Turks, Mughals, Pathans, some of Semitic, some of Mongolian, and some of Aryan stock, but all virile fighting races which had no hesitation in inter-marrying with those of the Aryan inhabitants who had embraced or were willing to embrace the religion of the victorious invaders. The Rajputs or fighting and ruling class in the Hindu social system of the north and west Punjab had probably never submitted completely to Brahmin supremacy, and as fighting men they had much in common with the Muhammadan conquerors. There was little or no national feeling then in existence to sharpen the religious difference; anyhow, whatever the cause, many of the Rajput tribes after a gallant resistance appear to have submitted to the inevitable and embraced Islam between the 13th and 15th centuries. The inferior races and castes were not slow to follow the lead of the superior, and except in the south-east of the Province, which was in close touch with the centre of Brahmin influence in the Ganges valley, the spread of Islam had been fairly spontaneous and complete before the persecuting policy of Aurangzeb drove many unwilling converts to seek safety of person and property in adhering, at least nominally, to the State religion. This fact is brought out in the village histories of many village communities in the south-east of the Punjab—and I have found the same in many Muhammadan villages in the States of Alwar and Bharatpur—which state expressly that in the time of Aurangzeb their ancestor or representative was summoned to Delhi and given the option for himself and his relations of embracing Islam or losing the village lands. They chose the former alternative which, perhaps, was less harsh than that—Hell or Connaught—offered by Cromwell to the Irish tribes that had fought against him. Passionate attachment to the land is a common quality of the Irish and the Punjabis—the most westerly and most easterly sections of the great Aryan race—and if the Irish were less ready to save their lands by conforming to the religion of the conqueror, the reason possibly was that in their case religious sentiment was reinforced by a spirit of nationality which at the time of the Muhammadan invasions was certainly non-existent in the Punjab.

Effect of Muhammadan Conquest on Racial Sentiment.

In proof of this I might cite the evidence of every authority on Punjab ethnology from Ibbetson, whose census report of 1881 is the classic authority, to Pandit Hari Kishan Kaul, who compiled the admirable census report of 1911. They all agree that, after Islam had obtained a preponderance in the Punjab, the various Hindu tribes and castes who had embraced the religion of the conqueror steadily endeavoured to repudiate their Hindu ancestry and to claim connection with the Arab, Afghan or Mughal invaders, or the Arab founders of the faith.

Any of you who know the Punjab will at once recall instances. I will cite two from my own experience. Prominent among the Kshatriya or Rajput tribes of the north Punjab who for at least two centuries strongly opposed the Ghazni and Ghori invaders, were the Gakhars, the Janjuas and the Tiwanas, —names familiar to and honoured by everyone who has followed the exploits of the Indian army. All these tribes are now orthodox Muhammadans, but broadminded and free from bigotry. Twenty-five years ago I used often to discuss the history of his tribe with Kaja Jahandad Khan, the head of the Gakhars, a gentleman of wide oriental culture. Over and over again he tried to persuade me—but without success—that the Gakhars were not of Hindu origin but descended from a section of the Arab Koreish, that had been driven out from their ancestral home near Medina, had trekked through Persia and Afghanistan in their wanderings and had finally dropped down into their present settlements in Hazara, Rawal Pindi, and Jhelum from Kashmir. The common use of the Rajput prefix Raja, the persistence of certain Hindu customs at marriages and funerals—all these practical arguments of mine had no effect on him. It was as if Hereward the Wake's descendants claimed to have come to England with Norman William, or a descendant of Brian Boru or Roderick O'Connor boasted that his ancestors came to Ireland with Strongbow, or even with Cromwell!

Again, in preparing material for a revised edition of Griffin's Punjab Chiefs—the Burke's Peerage of the Punjab—I asked that splendid old Tiwana veteran of mutiny fame, Risaldar-Major Malik Jahan Khan of the 18th Tiwana Lancers, to bring me his family tree. He appeared in my office at Shahpur one day with a formidable roll of papers. I suggested his opening out the family tree on my office table. He said that would be quite inadequate and spread it on the floor. We were both soon sprawling on the ground, following a genealogy which stretched from one side of the room to the other. I rather think it began with Adam, I am certain that Noah was a comparative *parvenu*. But the significant fact was that in the list of Jewish, Arabic and even Persian names there was not a single Hindu patronymic, though the Tiwanas are of undoubted Rajput descent like their kinsmen the Ghebas and the Sials. I had a similar experience with the head of the Janjuas, Raja Turab Khan of Katha Musral.

When such was the tendency of these who might rightly claim to be of the bluest Rajput blood, it is not surprising that the Muhammadans of lesser origin should also seek to magnify their status by alleging direct descent from the Muhammadan conquerors. The laxity of Islam in regard to purity of blood, as compared with the rigorous bar placed by Hinduism on any attempts, at least by the lower castes, to escape from their hereditary status, gave strong encouragement to that tendency and was probably one of the most potent influences in the rapid spread of Islam among those castes. The position is well summed up in the familiar Punjabi saying, "Last year I was a Mochi (a converted Hindu scavenger or outcaste), this year I am a Sheikh, (Muhammadan religious guide), next year if prices are high, Inshallah, I shall be a Saiyid (direct descendant of the Prophet)."

It will be seen that the growth of Islam in the Punjab has had a marked influence on weakening the old Hindu tribal and caste distinctions. That influence was further strengthened by the rise of the Sikh religion. It is, therefore, now convenient to turn to the second part of my subject—the religions of the Punjab.

II.—Religions of the Punjab.

According to the census of 1921, the population of the Punjab, including its native states and the small enclave of Imperial Delhi, was 25½ millions. Of these, in round numbers, 13 millions or 51 per cent are Muhammadans, 9 millions or 35 per cent. Hindus, 3 millions or 12 per cent. Sikhs. Of the remaining half million, 350,000 are Christians. Nine-tenths of the latter are Indian Christians who have increased from 4,000 to 315,000 within the last 40 years, chiefly by conversions from the lower castes and outcastes. The proportion of Muhammadans to the total population has in the same period risen from 47 to 51 per cent., of Sikhs from 8 to 12 per cent., while that of Hindus has fallen from 44 to about 35 per cent.

These changes are due to the fact that Islam, Sikhism and Christianity are all strongly propagandist, in theory at least repudiate caste, and have brought into their respective folds large numbers of the lower Hindu castes or outcastes, whose lot in the Hindu social system has hitherto been such a miserable one.

Hinduism and its Sects.

The flight from Hinduism among these submerged millions (there are still two millions of "untouchables" among the nine million Hindus) would have been even more rapid were it not that in recent years the Arya Samaj, a Hindu reformed sect, has intervened, and by a vigorous propaganda which is sometimes resented by the rival religions and not altogether popular with orthodox Hindus, has by the process of purification (Shuddhi) brought into the Hindu fold many tens of thousands of the lower castes and outcastes. In certain cases it has even recovered some of the lost sheep which had recently strayed into

the pastures of Islam. Thus the Arya Samaj which started fifty years ago as a body of enlightened Hindu reformers in revolt against Brahmin dominance and the arrogance of the caste system, now includes not only a large and steadily increasing proportion of the Hindu literati, but also a considerable number of the depressed classes, who have little or no Aryan blood, but whom it raises in social status by the grant of the " Janeo" or sacred thread, which is supposed to put them on an equality with caste Hindus. The Samaj has also established itself among the Hindu Jats of the southern Punjab, who have always been a sturdy independent race, resentful of Brahmin dominance and impatient of caste restrictions, such as the bar on widow remarriage. The Samaj claims that its founder Dayanand Saraswati did not give the Hindus a new religion; he drew their attention to what was old and latent in the Hindu mind. Undoubtedly it has done much good work in rejecting idol worship, in social reform, in discouraging child marriage and encouraging widow re-marriage. It adheres to the four Hindu castes, though holding that they are interchangeable by merit. At the start it showed no special veneration for the cow, but it has now become a staunch protector and thus strengthened its position with orthodox Hindus.

The Samajists were so few in 1881 that they were not separately recorded in the census. In 1891 they numbered 14,000 only, in 1911, 101,000 and in 1921 they had risen to 223,000. The increase is as marked as that in the Indian Christians and is due to much the same causes. But the Arya Samaj owing to its power in the press, the schools and colleges, the bar and the professions generally, and its strongly marked nationalist proclivities —for it regards a Hindu Aryan rule as the goal of national aspirations — has much greater influence in the Punjab than its mere numbers—2.5 per cent. of the Hindu population—would indicate. The Arya cult in Hinduism has naturally embittered the relations between the Hindus and the other religions of the Province, and while it has succeeded in ridding Hinduism of certain undesirable accretions, it has also shaken the foundations of orthodox Hinduism. It is significant that the Samaj itself, like most Indian social and religious movements, has also split up into parties. The Gurukul or ascetic section eschews all animal food, and the College or worldly section holds that in the severe climate of the Punjab animal food cannot be dispensed with.

The Arya Samaj is not the only new cult which Punjab Hinduism has thrown up. In 1887 the Dev Samaj sect was founded by a Pandit Satya Nand Agnihotri, better known under the high sounding title of "Shri Dev Guru Bhagwan," which if adequately translated would throw into the shade the Holiness of the Pope and the Beatitudes of the Eastern patriarchs. His mission, in his own words, was to bring Truth and Justice into the world by changing the minds and hearts of men. At first he sought to work this change through a belief in God and a future State, but after some years he considered the Divine agency was unnecessary. Hence, the cult, though it has some influential members and does good work in the way of promoting

temperance, education and social reform, numbers only a few thousand followers, and its atheistic tenets arouse the abhorrence of the strong monotheists of Sikhism and Islam.

Islam, indeed, with its clearly defined articles of faith by the belief in God and his Divine messengers, in his inspired prophet, in his revealed books, in the last judgment and the life after death, and its well-established methods of gaining spiritual merit by prayer, fasting, almsgiving and pilgrimage to the Holy Places, is much less tolerant of new religious development than Hinduism. The latter may be regarded as a racial, a social, or a religious organisation, or as all three combined. On the purely religious side it has from the earliest times been ready to assimilate any local or aboriginal cult which accepts the caste system and the two essential principles of veneration for the Brahmin and reverence for the cow. Given these, it is wide enough to dispense with any dogmas and to cover the most varied and even conflicting moral and religious ideas, nature worship, polytheism, pantheism, monotheism and even atheism. All of these may be seen co-existing among the Hindus of the Punjab to-day. But, owing to the predominance of the Aryan element, and the influence of the purer and simpler creeds of Islam and Sikhism, the grosser cults, associated with the worship of Siva the Destroyer and his consort Kali or Durga, which have probably been adopted from the aboriginal Dravidian or Mongoloid races and are common in Bengal and southern India, are not in favour with Punjabi Hindus. I think I am correct in saying that no Punjab Brahmin will take part in the worship of Siva or will partake of the offerings made at his shrine or that of his consort Devi or Kali. Siva's priests are a separate class, Gosains or Jogis. That fact goes to show that these deities are not Aryan but aboriginal.

There is no temple to Brahma, the Creator, in the Punjab, and his name, though honoured, is rarely heard; but the worship of Vishnu the Preserver is fairly common, and in the east of the Punjab the familiar Hindu salutation is "Ram, Ram." But, as Ibbetson remarks, those lords of creation are too high company for the villager, He will make the usual observance to them at the great festivals a few times a year, but his concern is with the host of local godlings, whose business it is to regulate the matters closely affecting him, and especially with those who can do him injury. The explanation of the superior attractions of the local deities was admirably given by a villager to Ibbetson, "We know the Governor who is above all is at Lahore. We worship him once every few years when he visits these parts. You as yet are subordinate to him, but you are here with us and we worship you daily and hourly."

If this does not express a lofty ethical conception, it is not wanting in practical common sense. I had an interesting corroboration of Ibbetson's views when in October, 1916, I visited the beautiful Kulu valley in the inner Himalayas on a recruiting campaign. The valley has

never been affected by Muhammadan or Sikh influence; its Hinduism has developed on purely indigenous lines; nature worship is common; every village and hamlet has its own local godling, with his or her separate temple lands and ministrants. Once a year at the Dasahra festival all these godlings are brought in in state by the villagers to pay homage to the god of the whole valley—a very sacred deity about the size of my thumb, known as Raghunathji, who was stolen from a famous temple at Benares at the instance of the then Kulu Raja three hundred years ago. My visit coincided with the great annual festival at Sultanpur, the capital of the valley. I went down to see it. Raghunathji was brought out of his shrine and placed on a dais. All the lesser godlings went by in procession and did homage to him as they passed. Both Raghunathji and the village deities held certain grants of land for their maintenance from the British Government of which I was the temporary representative. After due homage was rendered to Raghunathji, it was suggested by the Brahmins and others present that all the gods should show honour to me as the representative of the ruler. I was not at all anxious for this greatness, but it was thrust upon me and I was told it would have been churlish to refuse. I therefore took my stand by the platform; the 60 or 80 village gods marched past in gay procession and duly made obeisance to me. I took the salute, and the unique ceremony was crowned by the great Raghunathji himself rendering due honours. This improvised ceremony caused pleasurable excitement to the assembled thousands, and it certainly stimulated the recruitment among the kindly and loyal Kulu people. The incident shows how elastic and expansive Hinduism can be in its natural environment.

Islam and Its Sects.

But to return to Islam: the only two generally recognised forms are the Sunnis who constitute 95 per cent.of the Muhammadan population and the Shiahs, who are only two per cent., and according to the census returns are steadily decreasing. I refer specially to this point as many years ago I had some difficulty in persuading the then Secretary of State for India that the vast majority of the Punjab Muhammadans were not, as he thought, Shiahs. While both Sunnis and Shiahs have a well-defined position in the Islamic world, both, at least in the Punjab, are inclined to regard all other Islamic sects not as "fancy religions," but as dangerous heretics, little, if at all better, than the unbelieving *kafirs*. Hence their hostile attitude to the Ahmadiya sect founded some 40 years ago by Mirza Ghulam Ahmad of Kadian in the Central Punjab. The Mirza and his followers claimed that he was the Mahdi or Messiah expected alike by Islam and Christianity, and the *avatar* or divine incarnation of the Hindus, that he was divinely inspired, that his mission was to put an end to war and civil strife by appeals to the religious instincts in man, and that in pursuance of that gospel of peace and love the old Islamic doctrine of Jahād, the defence and propagation of

the faith by the sword, should be repudiated. On the death of the founder his mantle fell on successive *khalifas*, and the present *khalifa*, an enlightened gentleman, expounded the tenets of his creed at the Congress of religions held in London in 1924. The sect has made considerable progress among educated Muhammadans in the Punjab, and though the total number of adherents as recorded in the 1921 census was only 23,000, it claims now to have a total of a quarter of a million in India and the surrounding countries. It has a strong missionary organisation and maintains a mosque at Southfields, near Wimbledon. My own experience of the community in the Punjab is that, at a time of acute tension in the Muhammadan world, it remained steadfast in its loyalty and active in helping the British Government, keeping quite aloof from politics.

I have only time for a passing reference to the Shamshis, an obscure Muhammadan sect, who regard H.H. the Agha Khan as their head, and who are also looked on with some suspicion by the orthodox. Many Hindu *sonars* or goldsmiths are believed for some hidden professional motives to adhere secretly to this cult. But the total number recorded in the Census papers was under 10,000.

THE SIKHS.

Finally, I come to Sikhism, the religion which had its origin in the Punjab, is now professed by over three million Punjabis, and while it has few adherents outside the inhabitants of the province, gives vigorous expression to many of the most strongly-marked characteristics of the Punjab races and particularly of the typical Punjabi peasant—the Jat.

Sikhism, as pointed out by Ibbetson and others, was, like Buddhism 20 centuries earlier, a revolt against the pretensions of the Brahmins, the fetters of the caste system, and the exaggeratiou of Hindu ritual.

But Buddha living in Magadha, the very centre of Hinduism, while he rejected the gods of the Hindus, knowing no other, preached a vague pantheism, that there was no personal God, and that escape from the weariness of this world to Nirvana or Nothingness was to be found only in a blameless life. Nanak, the founder of the Sikh religion, was, like Buddha, a Kshatriya Hindu, and was born towards the end of the 15th century near Lahore in the borderland between advancing Islam and receding Hinduism, under the shadow of monotheism. He travelled far in Muhammadan lands and was on friendly terms with Muhammadan religious teachers. These circumstances profoundly influenced his teaching, which may be summed up in a few words—the Fatherhood of God and the brotherhood of man. He taught that there was but one God, not the Allah of Islam, nor the Parameshvar of Hinduism, but the God of all mankind and of all religions. While not attacking either Hinduism or Islam, he preached what was best in both. While claiming neither direct divine inspiration nor the miraculous powers which his followers have

credited him with in many beautiful incidents of his life, he declared himself a prophet (Guru) and propounded a simple but lofty moral code. He prescribed no caste rules or ceremonial rites, regarding these as unnecessary if not harmful; but he accepted the Hindu veneration for the cow (of which the Sikhs of to-day are the stoutest champions) and the Hindu doctrine of transmigration, as the means by which the soul became purified so as to rejoin its maker. In Ibbetson's words, he attacked nothing, he condemned nobody, he sought to draw men from the shadow to the substance and bring them nearer to their maker.

The followers of this peaceful and tolerant creed were known as Sikhs or disciples, and the doctrines spread steadily among the Hindus and even among the Muhammadans of the central Punjab. Nanak was held in equal reverence by both, and at his death both claimed him as their prophet and his shroud was divided between them. The shrine at Nankana that commemorates his birthplace was endowed by the local Muhammadan chiefs, the grant being confirmed later by the Mughal emperors and then by the British Government. But it was at this very shrine that in March, 1921, a body of 130 of the Puritan Akalis or Reformer Sikhs was massacred by the followers of the Abbot of the orthodox party, who believed that the Akalis intended to take forcible possession of the Monastery, its rich possessions and endowments. I had personally inducted the Abbot into these temporalities a few years before.

Nanak's quietist teachings were carried on by his successors, Gurus Angad, Amar Das and Ram Das, during the 16th century. Ram Das the fourth Guru about 1580 A.D. obtained from the tolerant Emperor Akbar—whose attempt to establish a new religion combining the best features of Hinduism and Islam may have been inspired by Nanak's teaching—a grant of the land on which now stands Amritsar (the pool of immortality). He began the excavation of the great tank and the construction of the Golden temple in its centre. This work was completed towards the end of the century by the fifth Guru, Arjun, a man of great enterprise and ability, who compiled the Adi Granth or Sikh scripture, amassed much wealth, and placed the Sikh religion and its followers under a definite organisation. Arjun's growing influence in the Central Punjab brought him into collision with the Mughal Empire, of which at that time Lahore was usually the capital.

Akbar was succeeded in 1605 by his son Jahangir. Jahangir's eldest son, Khusru, promptly raised the standard of rebellion, besieged Lahore, and rallied to his standard all such local forces as he could influence. He was however, defeated by Jahangir in 1606 and taken prisoner. Jahangir believed that Guru Arjun had assisted Khusru in his rebellion. In his memoirs he gives a most graphic account of the then Sikh situation and how he handled it. As the passage is little known, I quote it in full. Jahangir writes :—

"At Govindwal, on the banks of the Bias, there lived a Hindu named Arjun, who had assumed the part of a spiritual guide or Sheikh [he confuses Sikh (disciple)

with Sheikh, Muhammadan religious guide]. He made numbers of stupid Hindus, nay, even foolish and ignorant Musulmans, captives to his wiles and had the drum of his sanctity widely beaten. They called him Guru. Disciples flocked round him from all sides and evinced the greatest respect for him. They had been practising this mendacity for three or four generations. The idea struck me several times to put a stop to this trickery or to make the Guru a convert to Islam, till at last at this time Khusru crossed the river in that direction. The Guru wanted to see him and he happened to encamp at the place where the Guru lived. He had an interview with the Prince and supplied him with much information. He applied to the Prince's forehead the mark of saffron, called, in the dialect of the Hindus, Kashka: they do it by way of a good omen. No sooner did I hear of this than, convinced as I was of the absurdity of the notion, I ordered the Guru to be brought into my presence, I ordered his sons and his habitations and dwellings to be handed over to Murtaza Khan [the Governor of Lahore]. All his property was confiscated to the State and he himself placed in rigorous confinement."

In such words might one of the Claudian Emperors of Rome have described the measures taken to muzzle Paul or his successors and prevent the spread of the new cult of the Christians in the Imperial household.

This happened in 1606. The Guru was imprisoned just outside the Lahore Fort where his Samádh now stands. He died within a few months as the result of his captivity; but pious Sikhs believe that having obtained leave to bathe in the Ravi he miraculously disappeared in its waters. The blood of martyrs is the seed of the Church and thus began the series of conflicts between the Sikhs and the Muhammadan power which for centuries caused so much disorder and bloodshed in the north of India, and ended in the ousting of the Mughals and the establishment of a Sikh kingdom in the Punjab. As Elphinstone writes, "This act of tyranny changed the Sikhs from inoffensive quietists into fanatical warriors."

Har Govind, the son and successor of Arjun, inspired his followers with the spirit of revenge and hatred of the oppressor, and began that process of transforming the Sikhs into a militant nationality (similar causes led to the simultaneous growth of the Mahratta nation in Southern India) which was carried on by his successors Har Rai, Har Kishan and Tegh Bahadur and was completed nearly 100 years later by the tenth Guru, Govind Singh. The proselytising persecutions of Aurangzeb in the latter half of the 17th century stimulated that transformation. About 1675 the ninth Guru Tegh Bahadur was brought captive to Delhi because he had opposed the Emperor's attempts to force the inhabitants of Kashmir to embrace Islam. He was there beheaded under the Emperor's orders, and an interesting Sikh tradition attributes to him, before his execution, the prophesy of the coming of a race from beyond the seas that would root out his Mughal oppressors.

Guru Govind the last and greatest Guru succeeded his father in 1675, at the age of 15. He spent many years in organising his followers and preparing them for the final stage of militant Sikhism which he had evolved. This he

announced at a great gathering at Anandpur, under the shadow of the Himalayas, on the occasion of the Baisakhi festival. This was his proclamation :—

"Since the time of Baba Nanak, *Charan pahul* has been customary. Men drank the water in which the Gurus had washed their feet, a custom which led to great humility. But the Khalsa can now only be maintained as a nation by bravery and skill in arms. I now institute the custom of baptism by water stirred with a dagger and change my followers from Sikhs (disciples) into Singhs (lions). Those who accept the nectar of the *pahul* shall be changed before your very eyes from jackals into lions and shall obtain empire in this world and bliss hereafter. Let all embrace our creed and obliterate differences of religion. Let no man deem himself superior to another. Let no one pay heed to the Ganges and other places of pilgrimage. Let men of the four castes receive my baptism, eat out of one dish and feel no disgust or contempt for one another."

He then lays down these further rules for his followers :—

"They shall have one form of initiation, the sprinkling of water by five of the faithful ; they shall worship the one invisible God ; they shall honour the memory of Nanak and his successors ; their watchword shall be "Hail Guru" (Wăh Guru) ; but they shall revere and bow to nought visible save the Granth, the book of their belief.

"They shall bathe from time to time in the pool of Amritsar ; their locks shall remain unshorn ; they shall all name themselves Singhs or soldiers and of material things they shall devote their energies to steel alone. Arms should dignify their person ; they should for ever encourage War and great will be his merit who fought in the Van, who slew an enemy and who despaired not though overcome."

The Guru would probably not have qualified for admission to the League of Nations to-day. But is it any wonder that these glowing words stirred to their very depths the minds and hearts of the hardy, warlike men to whom they were addressed, and consecrated the Singhs to the service of arms ? In theory the religious principles of Nanak were retained ; the invisible God, the Guru and the Granth Sahib remained unchanged, but while Nanak inculcates holiness of life rather than caste observances and elaborate ritual, Govind in the altered conditions demanded, as the proof of faith, brave deeds and devotion to the cause. His disregard of caste and repudiation of the Brahmins alienated some of the higher castes, such as the Rajputs, but attracted the lower and especially the independent democratic Jat peasantry to his standard. These he inspired with his fervent hatred of the Muhammadan persecutors, telling them : "It is right to slay a Muhammadan wherever you meet him. Use your constant efforts to destroy Muhammadan rule. If they oppose you, defeat and slay them." Aurangzeb promptly took up this direct challenge. The Imperial forces were concentrated against the Khalsa. In the first great engagement near Ambala the Sikhs were routed and the Guru's mother, wife and children were cruelly put to death at Sirhind—a town still held accursed by the Sikhs.

For the moment Auraugzeb triumphed. He died soon after, in 1707, and the Guru was poisoned at Nander in the Deccan a year later.

But the cause remained. Banda, his disciple, succeeded to the command of the Khalsa, though never recognised as Guru, and won many victories over the Mughals, whose power was being sapped by the rapid growth of the Mahrattas, another militant nationality, in the South. But Banda was captured and executed in 1716, and thereafter followed decades of fierce persecution on one side and violent retaliation on the other. I need not pursue the growth of Sikh dominion beyond quoting Ibbetson's resumé :—

"How the troubles of the Delhi Empire thickened; how the Sikhs again rose to prominence; how they disputed possession of the Punjab with the Mughals, the Mahrattas, Nadir Shah the Persian, and Ahmad Shah, the Durrani invader, and were at length completely successful; how they divided into confederacies under several chiefs and portioned out the province amongst them; and how the genius of Ranjit Singh (a Sikh Jat) raised him to supremacy and extended his rule far beyond the Punjab, are matters of political and not of religious history."

We still have in Sikhism the cleavage between the tolerant quiestist doctrines of Nanak and the militant propaganda of Govind. The followers of the former are commonly known as the Nanak-panthis or Sahajdharis-Sikhs (i.e., who shave their heads and faces), the followers of the latter as the Singhs or Keshdharis (those who do not cut their hair). The latter are the typical Sikhs with martial traditions and of a well-marked racial type; they are steadily increasing in numbers while the former are decreasing. The Sahajdharis fell between 1911 and 1921 from 400,000 to 225,000; the Keshdharis rose from 2,400,000 to 2,900,000, and this fact seems to justify the Pathan saying that the strength of the Sikh is in his hair.

It is a well-known fact and an inevitable consequence of Guru Govind's teaching that Sikhism is weakened by peace and stimulated by war.

After the conquest of the Punjab by the British in 1849, Sikhism suffered a temporary eclipse. Sir R. Temple, Secretary to the Punjab Government, wrote, in 1853, that "the Sikhs are re-joining the ranks of the Hindus from whom they originally sprang, and the baptism of adults at Amritsar is now rarely performed." But, four years later, after the outbreak of the Mutiny, the Sikhs rallied to our cause in thousands, and Temple writes, in 1858, that Sikhism, which had fallen off so much, is again on the increase.

That great authority, Ibbetson, in the census report of 1881, when the total Sikh population was only 1,700,000, wrote, "On the whole there seems reason to believe that notwithstanding the stimulus of the Kabul Campaign, Sikhism is on the decline."

On the contrary, between 1881 and 1921 the number of Sikhs in the Punjab has almost doubled. The increase is due to various causes, the appeals of a simple creed with lofty but practical ideals to the virile and independent Jat peasantry of the Punjab who form the backbone of Sikhism; the great agricultural prosperity of the Sikh peasantry in the Central Punjab due to our wonderful irrigation system and the splendid outlet afforded to them in the new canal colonies; finally, the congenial career opened to Sikhs in the

Indian Army and the encouragement given to Sikhism by the military authorities ever since our conquest of the Punjab.

Lord Gough, who broke the Khalsa military power at Chilianwala and Gujrat in 1848-49, is often criticised for rashness in attack—a quality derived from his Tipperary tradition, "When you see a head hit it." But he has never received due credit for the generous chivalry by which he won over the hearts of the defeated but still not despairing Sikhs. Having driven the Sikh Army and their Afghan allies headlong across the Jhelum, he avoided a tedious guerilla warfare by a proclamation to his valiant opponents, recognising their gallantry, appealing to their practical sense to admit defeat, and calling upon them to lay down their arms and go back to their lands, changing the sword for the ploughshare, and offering those who needed it aid in renewing the peaceful pursuits of agriculture. The offer was readily accepted, and during my first ten years in the Punjab, from 1885 to 1895, many an old veteran of the Sikh wars told me how Gough Sahib's generosity had turned their hearts to the British Sirkar, and led the Sikhs to give us such timely and gallant support in the Mutiny under the direction of the Lawrences, Edwardes, Reynell Taylor, and others. Thus, from Gough's time dates that splendid association between the Sikh and the British soldier, which has been cultivated by successive Commanders-in-Chief—Gough, Roberts, and O'Moore Creagh, in the past, and Birdwood to-day. The old Sikhs used say of Gough, "Hathiyar nàl uràya, piyàr nàl wasàya" (he smashed us by arms, he restored us by kindness).

It was that brotherhood in arms that enabled the Punjab in the Great War to enrol nearly 100,000 Sikh combatants. Indeed, the annihilation of a gallant battalion, the 14th Ludhiana Sikhs, in a heroic advance at Gallipoli in June, 1915, did more than anything else to arouse their martial ardour, for they had not forgotten Guru Govind's message, "Great will be his merit who fought in the van, who slew an enemy, and who despaired not though overcome."

One result of the Great War has been a notable accession of adherents to Sikhism.

Captain Garret, the Recruiting Officer in Ludhiana in 1917-18, explains this. He writes:

"There are many families of Hindu Zemindars of whom those who had already joined the Army had, as a matter of course, become Sikhs. Those who stayed at home remained Hindus. When as a result of intensive recruiting these were induced to join up, they also became Sikhs. A Hindu Jat was taken by the Sikh Recruiting Officer on condition that he became a Sikh. Daily Ram Chand entered the Recruiting Office and left it as Ram Singh. So much so that Hindu Recruiting Committees protested that they were not getting full credit."

This is not the place to touch on politics, but all who take pride in the long and glorious connection between the Khalsa and the British rejoice that the temporary estrangement between the Government and a section of the Sikh Reformers has now been composed by the passing of a Bill which, subject to certain safeguards, gives the Sikhs reasonable control of their shrines and sacred places.

Effect of Religion upon Racial Qualities.

A well-known authority has summed up the outstanding features of the followers of the three main religions, as follows: the Hindu, thrift; the Musalman, pride; the Sikh, bravery. But while not contesting the pre-eminence of the Sikh, neither the Punjab Hindu or Musalman, at least of the landowning tribes and castes, is lacking in martial spirit. During the Great War 360,000 fighting men were raised in the Punjab—more than half the total raised in all India. Of these, the Hindus, with 35 per cent. of the population, supplied 25 per cent., the Sikhs, from 12 per cent. of the population, another 25 per cent., the Muhammadans with 51 per cent. of the population, supplied 50 per cent. Seeing that in the East, Islamic Turkey was our chief antagonist, and that our Indian recruits were raised primarily to fight against the Turks on Islamic soil, the fact that 180,000 came forward is a signal proof of the loyalty and the valour of the Punjab Musalmans. Many of them on their return from the Irak and Palestine campaigns told me that while the Turk was good enough as a fighter, they had the poorest opinion of him as a Musalman. Their loyalty and commonsense were further shown in their refusal to be drawn into the Khilafat movement after the war.

I now return to the main question of the division of races and castes according to religions. It is a significant fact, as pointed out by Pandit Hari Kishan Kaul, that there is no word for race in any Indian vernacular. There is the Hindi word *zat* to denote caste, which is often used as synonymous with tribe, and there is also the Arab word *kaum* to denote tribe. From this we may gather that the Muhammadan invaders and immigrants recognised the tribal organisation with which they were already familiar; the earlier races who remained Hindu, if they recognised such a thing as race at all, identified it with caste, which had by then become a hereditary institution, while those who embraced Islam regarded caste and tribe (*zat* and *kaum*) as synonymous.

Of the 13 million Muhammadans, about 2 million claim an extra-Indian and purely Muhammadan origin, and in the case of the Biluch, Pathan, Mughal, Saiyid Kureshis, and most of the Sheikhs—1½ millions in all—the claim is indisputable.

Similarly there are certain castes, such as the Brahmin, Khatri (Kshatrya), Arora, Baniya, Kanet—some 2¾ out of 9 millions—that are exclusively Hindu or Sikh.

Nearly all the other main tribes and castes, several hundreds in number, are distributed among the three great religions—a fact which shows that Islam and Sikhism, though in theory repudiating caste, were compelled in practice to acknowledge it. Indeed, that brilliant Muhammadan writer and poet, Sir Muhammad Ikbal of Lahore, deplores the fact that the Muhammadans suffer from a double caste system, their own sectarianism and the caste system of the Hindus.

That is notably the case with the two greatest and most distinctive races in the Punjab, the Rajputs and the Jats, who between them make up nearly one-third of the population, and own about two-thirds of the area.

THE JATS AND THE RAJPUTS.

Of the 5½ million Jats, nearly two millions are Sikhs (forming 60 per cent. of the total Sikh population), more than 2½ millions are Muhammadans and over a million are Hindus. Of the 2 million Rajputs, a million and a third follow Islam, half-a-million are Hindus, and comparatively few are Sikhs, either because the Rajputs were alienated by Guru Govind's democratic anti-caste teachings, or because they have become assimilated with the Jats; for Jat-Sikh is the racial or tribal qualification of which the Sikh is most proud, and the Sikh ruling princes of the Punjab come of that stock. Indeed, over much of the Punjab, and especially in the Western or Islamic area, the dividing line between Jats and Rajputs is a very vague one, and most authorities agree that, in the past at least, tribes or families, whatever their origin, who succeeded in acquiring ruling powers over any considerable area, were sooner or later admitted to the rank of Rajputs, which really means descendants of Rajas or rulers. We can trace this process in the not remote past. At least two of the ex-ruling families of the Kangra Hills, now recognised as typical Rajputs, are undoubtedly of Brahmin origin, and we see to-day ruling families of Jat origin, with social ambitions, raising themselves in a few generations to the Rajput hierarchy, chiefly by inter-marriage with Rajputs of blue blood. Money and social influence can do much to influence even caste.

Sir James Lyall, who had an unrivalled knowledge of the Rajputs in the Kangra Hills where Muhammadan influence never penetrated, writes :—

"Till lately the limits of caste do not seem to have been so immutably fixed in the hills as in the plains. The Raja was the fountain of honour and could do much as he liked. I have heard old men quote instances within their memory in which a Raja promoted a Ghirath to be a Rathi and a Thakur to be a Rajput."

Ibbetson quotes further instances to support this view and aptly points out that this power of tempering the caste system by Rajputs of position and power disappeared in the Punjab plains where the once powerful Rajputs, wielding secular authority, were ousted by the Muhammadan invaders, and the Brahmins took their place as leaders of the Hindu community—for the Brahmins, with their Levitical organisation, always insisted on caste being hereditary.

However that may be, any one familiar with the Jats and Rajputs of the Punjab cannot but recognise from their similarity of physiognomy and feature and their many common characteristics, that they come of the same ethnic stock, though perhaps representing separate immigrations, and that the stock is predominantly Aryan, with an admixture of aboriginal races which increases as one proceeds from the Indus to the Jumna. The differences between Rajput and Jat are not ethnical and fundamental, but a result of differences of tradition and environment. The Jat's marked racial qualities are but little

affected by his religion and environment. His sturdy independence, love of the soil and dogged tenacity, are the foundation of the prosperity of the Punjab; his love of a fight is the mainstay of our military power, and a perpetual thorn in the side of our civil authority. Ibbetson sums him up with characteristic humour and insight:—

"The Jat, as a rule, is a man who does what seems right in his own eyes, and sometimes what seems wrong also, and will not be said nay by any man. When he does go wrong he takes to anything from gambling to murder, with, perhaps, a preference for stealing other people's wives and cattle."

Doubtless it is the above qualities that have induced the great majority of Jats of the Punjab to embrace Islam and Sikhism; while those that are still Hindus do not readily bow to Brahmin domination or the pretensions of caste. But the protection of the sacred cow is a cry to which they will always rally. The Jat has a rough sense of humour, and, like the Pathan, will enjoy a joke at his own expense. A few of his proverbs bring out this:—

"A Jat, a Poet, a Caterpillar and a Widow. These four are best hungry. If they eat their fill they are ripe for mischief."

There is one glorious saying which, to my mind, admirably expresses the Jat character:—

"The Jat reaped his crop, stood on his corn heap and shouted to the King's elephant drivers, 'Ho, there, what will you sell those little donkeys for?'" In my time the more educated urban folk of the Punjab were inclined to sneer at the Jat as a dull, bucolic and even bovine, creature. In thirty-three years experience of the Jat—Muhammadan, Sikh and Hindu—from the Indus to the Chambal, I never found him wanting in character and interest, and those rural parts of India where the Jat had not penetrated seemed by comparison dull and insipid.

The Rajput.

The Rajput, even of the Punjab, while in many respects similar to the Jat, is more varied in type. He is as brave as the Jat, but less tenacious, less democratic, less industrious, less practical. Pride of blood is more strongly marked, the feudal instinct is more highly developed, and whether Hindu or Muhammadan, more deference is paid to the tribal heads He is inclined to look down on agriculture or manual labour of any kind, though in the Western Punjab he regards cattle-lifting as a gentlemanly pursuit. With him tradition and custom are much stronger than with the practical-minded Jat; the Muhammadan Rajput does not recognise widow re-marriage, which is almost universal amongst the Jats, even when they are Hindus or Sikhs, and secludes his women folk; he also clings to many Hindu social customs which are repudiated by orthodox Islams.

This, indeed, applies to most of the rural population, for, as pointed out by Ibbetson, I think, they are bound by social and tribal custom far more than by any rules of religion. I have come across many Muhammadan tribes in the

South East Punjab and Rajputana of whom it could be rightly said that they kept the feasts of both religions, the fasts of neither! Where the prevailing tone and feeling of the countryside are Indian and Hindu, as in the Eastern Punjab, the rural Musalman is often the Hindu with a difference; where the tone and feeling are of the Islamic country beyond the Indus, as on the Punjab frontier, the Hindu is almost as the Musalman. That is less true to-day, for in Islam, Hinduism and Sikhism there has been a great religious revival due to various external and internal influences which need not be referred to here. As a result there is a growing knowledge of the principles and rules of the rival faiths which has to some extent penetrated even to the rural masses. But this greater knowledge has, unfortunately, led, not to greater mutual toleration, but to an increase of religious polemics and sectarian hostility. In the Punjab the lines of cleavage between the three great religions, which in the past, as a rule, lived harmoniously side by sde, are far more marked to-day than they have been for generations. For the time religious animosities are, in many ways, stronger than racial realities.

Strength or Rural Custom.

But there is one respect in which the Punjab races have clung and will continue to cling to their traditions and customs regardless of any dividing or antagonistic religious influences; that is their customary law regarding the land. I have said above that in the past many Hindu tribes had embraced Islam to preserve their ancestral acres. But while embracing Islam they never accepted the Islamic law as to occupation and inheritance. Nor do those who are still Hindus accept the Hindu law as governing this most cherished of their possessions. All Punjab landowning tribes, whether Hindu, Muhammadan or Sikh, with a few insignificant exceptions, have evolved their own common code of customary law, which indeed has been forced on them by circumstances, and which is based on the principle of agnatic succession through males, the root principle of the immemorial village community.

Not only have they successfully withstood, in this and cognate matters of rural social economy, all the disintegrating effects of centuries of invasion and conquest, all efforts of Maulvi and Pandit to impose the doctrines of the Kuran or of the Shastras. They have even converted to their way of thinking the Brahmins, Khatris and Aroras, who in other respects are orthodox Hindus, and also the Saiyids, Kureshis and other races of purely Muhammadan origin—not to mention the Biluchs and Pathans—who everywhere else follow the Islamic law of inheritance. As far as I am aware this extraordinary vitality of custom is confined to the Punjab; it is bound up with all that the Punjabi holds dearest in this life. Could there be a stronger proof of the strength of heredity, of the permanence of the institutions evolved by the Aryan immigrants four thousand years ago, of the triumph of race even over religion—and even in that East which is said to take its religion alone seriously, its politics and all else lightly?

DISCUSSION.

The Chairman said Sir Michael O'Dwyer had certainly placed before the meeting that afternoon ample food for thought. In the course of less than an hour he had given an admirable epitome of the racial and religious history of the Punjab extending over a period of 4,000 years or more and in doing so had shown very clearly that he possessed not only the qualities that went to the making of an administrator and a strong ruler, but all those qualities of imagination and sympathetic insight which enabled him to understand and appreciate an outlook upon life which differed widely from his own—qualities, it might be emphasised, without which no man at the present day could hope to administer successfully either the Punjab or any other part of the vast continent of India. He did not know whether it would be regarded as impertinent if he, a Scotsman, were to suggest that in the outstanding characteristics of the average Irishman were to be placed pugnacity on the one hand and emotion and imagination on the other. Those characteristics were apt to be brought to the surface by external circumstances, and perhaps, as it might seem to the superficial student of recent Indian history, those circumstances during the latter part of Sir Michael O'Dwyer's service in India were such as to excite his pugnacity, but the paper which he had read that afternoon would show that below the surface the other qualities of which he had spoken were equally active. Sir Michael O'Dwyer naturally took a very proper pride in the Punjab as his own province. Much of that which he had claimed for the Punjab that afternoon most people would be prepared to concede, but perhaps in his excessive zeal he had in one or two respects claimed for the Punjab even more than the Punjab was entitled to. He had been a little surprised, for example, to hear him declare that the Punjab was the centre from which the great principles of Buddhism were diffused to western and eastern Asia. He should imagine that most people—including Sir Edward Gait, who was present that afternoon—would dissent from that view. Buddha was born in the kingdom of Magadha, a long way east of the Punjab, and his ministry was conducted in that kingdom, within the limits of which he died. Two or three hundred years later the great Emperor Asoka, who was responsible for giving to Buddhism its tremendous hold upon humanity, was likewise the ruler of the Mauryan Empire the centre of whose power lay in the Kingdom of Magadha, and it was to that Kingdom, which corresponded roughly to the present-day province of Bihar and Orissa, that the Chinese pilgrims drifted at different periods in order that they might study the tenets of Buddha's great doctrine. It seemed, under those circumstances, that it would be rather fairer, both to his old Province Bengal, and to the province over which Sir Edward Gait ruled with such success, Bihar and Orissa, that they should at least be allowed to be regarded as comprising that part of India from which the light of Buddhism spread to the rest of Asia. Sir Michael had laid stress, and very rightly so, upon the wide differences which separate peoples who, although they might profess the same religion and live side by side, nevertheless were separated by wide social differences, differences that divided the Baluchi tribes from the Mahsud Wazirs, the Baluchi tribes being amenable to the authority of their own head man or chief, and the Mahsud Wazirs, on the other hand, being very far from amenable to the authority of any one man and amenable in reality only to their own authority, although possibly in theory to the authority of the tribal Jirga. He could not help feeling that if those differences had been realised by the authorities of the day there would have been less difficulty and trouble in dealing with the perennial problem of the north-west frontier. Many of the difficulties in the eighties and early nineties of the last century certainly arose from the fact that, impressed with the success which our policy with regard to the Baluchi

tribes had achieved, we assumed that a similar policy would be equally successful in dealing with the tribes of the Mahsud Wazirs. It was only after the expenditure of much blood and treasure over many years that we at last realised, as had been pointed out that afternoon, that it was impossible to deal with a democratic people like the Mahsud Wazirs on the same lines as it was possible to deal with the Baluchi tribes. One other thought had occurred to him as he listened to Sir Michael O'Dwyer's description of the various religious movements which had had their birth in the Punjab, and this was that among the virile races found in the Punjab could be perceived the same movements in the direction of religious purity and simplicity as were observed amongst our own people in our past history. The same Protestant and Dissenting movements associated with the names of Luther and Wesley and others in the case of Christianity were to be observed in regard to religions in the Punjab. The examples given by Sir Michael O'Dwyer of the Arya Samaj in the case of the Hindus, and the Ahmadiya in the case of the Muhammadans, and much more recently, of the Akali in the case of the Sikhs, were all Protestant movements away from ritual and back in the direction of first principles, and it was somewhat interesting to perceive that movements of that kind had taken place mainly in the northern part of India and chiefly in the Punjab. It seemed to suggest that there was a strong connection between the virility of a race and its tendency towards purity and simplicity. One other point had also struck him very forcibly, and that was that, in the Punjab at any rate, race and religion did not necessarily go together. That was most strikingly brought out, he thought, in the case of the Rajputs and Jats. The former were originally a powerful aristocracy of the Hindu military caste, but now included an actual majority of Muhammadans, and the same state of affairs was to be observed in the case of the Jats. Anybody therefore who started with the assumption that in India race and religion necessarily went together would find he was making a very grievous mistake. It did not fall to his lot at the moment to propose a vote of thanks to Sir Michael O'Dwyer, but before calling upon Sir Edward Gait, the late Governor of Bihar and Orissa, to take part in the discussion, he would venture to express to Sir Michael his very profound appreciation of the trouble he had taken and of the sympathetic knowledge he had shown in placing his views before the meeting that afternoon.

Sir Edward Gait, K.C.S.I., C.I.E., said Sir Michael O'Dwyer had given an interesting and vivid picture of the racial and religious characteristics of the Punjab, where he spent the greater part of his long and distinguished Indian career, and had enriched his narrative with numerous interesting personal touches, and probably none of those present that evening would ever forget his priceless story of how he took the salute of the procession of village gods in the Kulu Valley. Sir Michael was a master of apposite anecdotes. He remembered, as Census Commissioner, discussing with him the vexed question of the proportion of the sexes in India, when in a few sentences Sir Michael related an experience of his own which proved that in one section of the community at least the deficiency of females was fully accounted for by the former practice of female infanticide.

The first matter he should like to refer to was that mentioned by the Chairman. There was, of course, no doubt whatever that Buddha obtained his enlightenment at Gaya and that the Great Emperor Asoka propagated the religion throughout India, including the Punjab. It was formerly believed that he also sent his missionaries to China, but later research, he thought, had shown that that belief was not well founded, and that as a matter of fact Buddhism did spread to China from Khorasan across Central Asia.

It had been said that all the Eastern races that entered India during the last 4,000 years came in through the Punjab corridor. That was true, but the immigrants referred to, commencing with the Indo-Aryans or Nordics or proto-Nordics, as they are now called, were by no means the only invaders of India. From time immemorial people had found their way into India from the North West and North East. There was a very large Mongoloid or yellow element in Bengal, and this element was still stronger in Assam, which must clearly have been the corridor through which it was introduced. The earliest of the Mongoloid invaders spoke dialects of the widespread Austric linguistic family which had its origin somewhere in the South of China. Dialects belonging to that family were still spoken in Assam and in Chota Nagpur, and even in the Punjab dialects were spoken which had an Austric sub-stratum. Thus, though the later invaders entered India through the Punjab, the Punjab itself at a more remote epoch obtained people from the opposite corner of India through Assam.

He did not dispute Sir Michael's view that inheritance or race was the principal factor in human development, but he thought there should be stressed also the great influence of environment, social and physical. The difference between the Sikhs and the Hindus in the Punjab to-day was due entirely to their creeds and social customs and not at all to race. In the same way climate had a very great influence. The great difference between the stalwart Tibetans and the comparatively feeble Ahoms was largely due to climate. The physical deterioration of the latter was a matter of history, for a Muhammadan writer about 300 years ago bore high testimony to their martial prowess and power of physical endurance. In recent years evidence had been accumulating to show that various physical characteristics formerly believed to be evidence of race were largely matters of environment. That had long been recognised in regard to colour. More recently head shape also had been shown as being liable to change. Professor Boaz in America had shown that the children of European immigrants, even when born very shortly after the parents arrived in America, had heads of a very different shape from those of their parents. The latest development in that direction had been with regard to the shape of the nose, on which so much stress was laid by Risley and other writers on Indian ethnography. It was now said that the shape of the nose tended to vary in accordance with climatic conditions. It was depressing to find how far things had moved from the good old simple time when it was assumed that language and race were synonymous terms. To-day it was difficult to say anything definite with regard to race.

Lieut.-General Sir Raleigh Egerton, K.C.B., K.C.I.E., said his qualifications for speaking on the subject were simply those of a military man who served about 35 years chiefly with the Punjab races and others from beyond the border. Sir Michael O'Dwyer had included the North West Frontier in the scope of his remarks, and although that had been divorced politically from the Punjab he did not think it had been separated economically or socially, or that it ever could be. It had really to be linked with the Punjab for the purposes of development. The North West Frontier Province was a very barren country, not self-supporting. The best description of it, he thought, was that given by the late Sir Lepel Griffin many years ago, when Chief Secretary to the Punjab Government, who, on returning from the Frontier, was asked by a lady what the frontier was like, and replied that the frontier was a " barren desert bounded on the East by the River Indus and on the West by some camel-coloured hills." With regard to the races in the Punjab, people were rather inclined to talk about certain races, the Sikhs or Punjab Muhammadans, for example, as being all fighting men, but his idea of the coloured races was that in every

part of the world it had been the genius of young Englishmen to make fighting men out of every class. In some races the percentage was very high and in others low, but the young English subaltern had always been able to make a certain proportion into fighting men, instilling them with martial ideas and ideas of discipline and loyalty. He believed that in every part of India a certain number of fighting men could be found, although perhaps a rather negligible proportion in some cases. The Punjab certainly did show a higher percentage than most. For military service there were in the Punjab the Sikhs, the Punjabi Muhammadans, the Dogras and others, who produced a fine stamp of fighting men, and there was a small community of Brahmin and Khattri Hindus which produced a good number of fighting men. Those men had retained their ancient Hindu religion in the midst of Muhammadans, and were extremely proud of their race ; it was really pride of race that made them such good fighters. There were a certain number in the Guides and in the 11th Bengal Lancers, and he thought they had more decorations for bravery in the field, in comparison with their numbers, than most others. He did not think any of the races made good soldiers unless they were properly led. He remembered talking to one member of Ranjit Singh's Army who had enlisted in the Guides as a non-commissioned officer. He said to that Sikh, " You know that you had a large Sikh Army and we came at you with a very small number of British and mostly down-country troops, which you despised, and yet we beat you." The Sikh replied, " Those regiments had very nearly as many British officers as the British regiments, and it was the Chhota Sahibs who led them that were the cause of our defeat." The fighting spirit in peace was only kept alive by military service, and one reason why it had become lukewarm among the Sikhs was that the Sikh women did not get away from the Brahmin priestly influence which must have affected the military spirit amongst their men. For military purposes there must really be good selection and good leadership. The Mahrattas about 100 years ago had a high reputation for military spirit, but about 25 years ago the Mahratta regiments were rather regarded as being worthless. They completely refuted this in the Great War. He had travelled to India with a man who was in command of one of these regiments, and in the course of discussion he asked him how the Mahratta regiments liked Aden, and was told in reply that they enjoyed it very much because their women and children worked in the coffee bazaar and earned money. He pointed out that no fighting man would ever allow his women and children to mix with Arab coolies, and the reply was that they were recruited by native officers who went to the villages and selected low caste men who would fetch and carry for them. Selection was all-important in enlistment ; in taking a man for military service, besides physical qualities, it was necessary to look into his eyes for human intelligence. He had also known of failure through a bad selection of officers. Two regiments were raised simultaneously about 40 years ago from the same class, brothers being in the different regiments. One regiment had a good set of officers, and always had distinguished itself, and the other had weak officers, and the latter regiment, on one occasion, really disgraced itself. The second in command used to abuse the Indian officers and men in a most abominable way. If men were called " dirty dogs " they would behave like dirty dogs ; it was not possible to get men to do anything well if they were treated badly. Even good men required good leaders. It was now the intention in India to Indianise the Indian Army, and he wished the process all success, but he did not know of many Indians who could really stand the strain and responsibility of a ticklish military situation. It was a great pity that in the re-constitution of the Indian Army one or two classes had been included which were not suitable. There

were a certain number of Gujars enlisted who might be admirable men, but it was no use sending a flat-footed, short-sighted Gujar into the Mahsud country to fight the Mahsuds. The Gujar might be a good man in his own flat country, but he could not meet the Mahsud in his mountains. With regard to the Indian Navy that was to be formed, he did not know where the fighting sailor would be obtained except from amongst the Muhammadans of the Punjab, who he believed would make good sailors, and were one of the few classes venturous enough to undertake such work.

MRS. BELL said it had always been of great interest to her to discover the 'idea' they had in the Punjab of a Sahib. To the women of the Punjab the Sahib was a surprising visitation, a stranger; what they knew of him they knew through their own men, and they thought of him as their men wanted them to think.

Mrs. Bell related some of her experiences in the Punjab, and gave several instances of the loyalty and devotion of the Punjabis and their womenfolk.

SIR EDWARD D. MACLAGAN, K.C.S.I., K.C.I.E. said he could not avoid adding his tribute to Sir Michael O'Dwyer for his very vivid and sympathetic lecture which had revived a number of memories in those who knew the Punjab. He should like merely to refer to one or two matters more or less of a literary character. The main authority with regard to the tribes and religions of the Punjab was that monumental census report of 1881 by Sir Denzil Ibbetson, one of the best and finest productions brought out in India on a subject of that kind. In the Punjab Government about 15 years ago the report was found to be of such a size, a big imperial octavo, that it would not go into any office box and no officer was able to take it about with him. They tried to get it brought up-to-date and re-published; the re-publishing was easy enough, but to bring it up-to-date was rather a large order, and he was deputed to open negotiations with Sir H. Risley on the subject, who replied that he was only one man who could bring the book up-to-date, but he had not the time to do it. The book, therefore, had to be re-printed as it was in a more convenient form and had become very useful to officers in the Punjab. There was a great deal to be done in the way of getting at the origins of the various tribes in the Punjab, and in the South-Western Punjab they tried to do something to get at the traditional origins in a more or less systematic manner. There was in the village records a short account of the origin of each village, showing how the tribe came to the village and where they came from. About a thousand of those records were collected and collated and a good many interesting results were obtained. The tribes in the South-West Punjab were however of a very isolated character and the results were not quite what were expected. The same process would be probably more useful in the centre of the Punjab where the tribes were larger. He remembered one incident when visiting a small village in which there was a tribe unknown anywhere else. He was talking to the head-man of the village who was complaining a good deal about his position and said to him "I see in the account of your village that your tribe is said to have come from Russia: is that true?" He said "Yes, and if the Government does not deal with the moneylenders we are going back again." (Laughter.) There was a good deal to be said on the points brought forward by Sir Michael about the respective influences of religion, environment and race. There had been many cases of people of exactly the same race living together in a village or in adjacent villages whose characteristics were now utterly different from each other, and that matter could be investigated in many ways. There was also the interesting question of the manner in which each race had become converted to Muhammadanism

or Sikhism as the case might be, and the reasons which made them change their religion. Even in Ireland, which Sir Michael had mentioned as a parallel to the case of India, the history of such matters was not at all free from difficulty. Probably there was no county in Ireland in which the inhabitants were thought to have adhered more strongly to their old faith than in Tipperary, of which Sir Michael was an honoured son, and yet there was historical evidence which showed that they went even further than Cromwell would have wished them to do. He had read a book published about a hundred years ago which described Connaught as being bounded on the north and west by the Atlantic Ocean and on the east and south by Christendom and a part of Tipperary.

A vote of thanks to the lecturer having been passed, with acclamation, the meeting terminated.

NOTES ON BOOKS.

SIR EDWIN CHADWICK. By Maurice Marston. London: Leonard Parsons, 24, Devonshire Street, W.C.1. 4s. 6d. net.

Here we find a vividly written appreciation of the notable work performed by Edwin Chadwick during the nineteenth century. His range of life was from 1800 to 1890, and his activity in public life may be said to have commenced when he became secretary to Jeremy Bentham in 1830, although two years previously he was known as the author of a thoughtful article on life insurance, in which he revised and corrected the work of an actuary who had given evidence in a parliamentary enquiry.

This early study of Chadwick in relation to life insurance was the keynote of all his subsequent public activities, and the mainspring of a life which in its broad aspect was a steady strain of tense effort for improving the health and the general well-being of the masses. Sir Edwin Chadwick's official career came to an end in 1854. His mind was active to the end, his later years being devoted to various public tasks.

Mr. Marston's contribution to that series of pocket volumes on British biography which includes the work under notice, is crowded with interesting details showing the personal determination of Chadwick. The characteristic portrait which depicts Sir Edwin in his advanced age will be valued.

THE ROMANCE OF THE FUNGUS WORLD: AN ACCOUNT OF FUNGUS LIFE IN ITS NUMEROUS GUISES, BOTH REAL AND LEGENDARY. By R. T. Rolfe and F. W. Rolfe. London: Chapman and Hall, Ltd. 12s. 6d. net.

The first charm of this book likely to impress the reader is its profuse illustration with photographs which by their full range of tone, appropriate selection or control of lighting, fine detail, clear printing and absence of distortion, do credit to all concerned in their production. Each photograph carries its lesson or story; thus in the frontispiece we get a view of the shingle-like flaps of the Dryad's Saddle growing out of the bole of a giant of the Forest, the single word "Doomed" forming a title to the picture and an item of instruction, which the reader can supplement by turning to p. 161, where he may read of razor strops made from the "leather" of this fungus, also of other varieties, while on p. 249 he may read of a Dryad's Saddle, which in three weeks attained a weight of 34 pounds.

A second charm of the book is the admirably written text—lucid, easy even for a child to understand; concise or unwasteful of words, and in close relation to the illustrations.

The third is the crowning charm : sound and exact science, so that the book is an important contribution to Mycology, a branch of study in which both the authors are well known. References to sources are abundant and cover ancient and modern writings.

OBITUARY.

SIR PHILIP WATTS, K.C.B., LL.D., F.R.S.—Sir Philip Watts died at his residence in Hans Crescent on March 16th, at the age of 79.

A great naval architect, he came of a family which had been engaged in the construction of warships for generations, his father, grandfather and great-grandfather having all been master shipwrights. He was born in 1846, and after a course of training at Portsmouth he passed the Royal School of Naval Architecture in 1870. In 1884 he joined the staff at Chatham Dockyard, but in the following year he succeeded Sir William White as Naval Architect and Director of the War Shipbuilding Department of Sir W. G. Armstrong, Whitworth and Co., Ltd., of Elswick-on-Tyne. He remained for sixteen years with this firm, and during this period he designed a large number of warships for Argentina, Brazil, Chile, Norway, Portugal, Turkey and Rumania, and he played an important part in building up the modern Navy of Japan.

On the retirement of Sir William White from the Directorship of Naval Construction for the Admiralty, Sir Philip was again chosen to succeed him. Among the first big ships which he was called on to design were the Agamemnon, Lord Nelson, Duke of Edinburgh and Black Prince. But he will probably be best remembered for his work in connection with the designing of the Dreadnought. This battleship was the outcome of the deliberations of the newly formed Designs Committee of the Admiralty, and its construction involved a number of new problems, which were solved successfully by the Director of Naval Construction.

Sir Philip Watts remained with the Admiralty till 1912. Of the 34 battleships and battle-cruisers present at the Battle of Jutland, no fewer than 29 were designed by him, and he was also responsible for the designs of numerous other types of vessels, such as torpedo craft, etc. In recognition of his valuable services to the Navy he was created a K.C.B. in 1905.

Sir Philip joined the Royal Society of Arts in 1898. He served on the Council in 1910 and 1911, and in 1921 he was elected a Vice-President, a post which he held up to the time of his death. He was also a member of the Thomas Gray Memorial Committee, in the work of which he took a great interest.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 29..British Architects, Royal Institute of, 9, Conduit Street, W. 8 p.m. Special and Business Meetings.

Actuaries, Institute of, Staple Inn Hall, Holborn, W C 5. p.m. Mr. G. H. Recknell, "The Bonus Earning Power of a New Business Fund."

Farmers' Club, at 12, Great George Street, S.W. 4 p.m. Mr. G. W. Monier-Williams, "The Production of Industrial Alcohol from British Vegetable Products."

Special Libraries and Information Bureaux, Association of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 2.30 p.m. Inaugural Meeting.

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. The Rev. Canon A. Lukyn Williams, D.D., "The Problem of the Septuagint and Quotations in the New Testament."

Chemical Industry, Society of, at Burlington House, W. 8 p.m. Major T. G. Tulloch, "Surface Combustion."

TUESDAY, MARCH 30..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.15 p.m. Mr. A. F. Geddes, "Some Villages of Western Bengal."

Illuminating Engineering Society, at 15, Savoy Street, Strand, W.C. 7 p.m. Mr. H. Lester Groom, "Stage Lighting."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. E. Ford, "Some Marine Researches and our Sea Fisheries."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Meeting of Kinematograph Group.

WEDNESDAY, MARCH 31..Electrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Mr. E. V. Clark, "Power Factor and Tariff."

Hygiene, Institute of, 28, Portland Place, W. 3.30 p.m. Dr. H. W. Barber, "Some Disorders of the Skin during School Life and Their Prevention."

Royal United Service Institution, Whitehall, S.W. 3 p.m. Lieut.-Colonel H. D. G. Crerar, "The Development of Closer Relations between the Military Forces of the Empire."

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FRIDAY, APRIL 2nd, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

CANTOR LECTURE.

MONDAY MARCH 29th, 1926. MR. W. F. HIGGINS, M.Sc., Principal Assistant, National Physical Laboratory, Teddington, delivered the third of his course of three lectures on "Thermometry." On the motion of the Chairman, a vote of thanks was accorded to Mr. Higgins for his instructive course.

The lectures will be published in the *Journal* during the summer recess.

REPRINT OF CANTOR LECTURES.

The Cantor Lectures on "Coal Ash and Clean Coal," by R. Lessing, Ph.D., M.I.Chem.E., have been reprinted from the *Journal,* and the pamphlet (price 2s.) can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A full list of lectures which have been published separately and are still on sale can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 24TH, 1926.

PROFESSOR LEONARD HILL, M.B., F.R.S., Director of the Department of Applied Physiology, National Institute of Medical Research, Hampstead, in the Chair.

The following paper was read :—

DOMESTIC HEATING.

By MARGARET FISHENDEN, D.Sc., F.Inst.P.

(Fuel Research Division, Department of Scientific and Industrial Research.)

There are many widely different angles from which the problems of domestic heating may be surveyed. To the architect or builder, questions of the capital cost of alternative equipments may loom large in the foreground; the householder, on the other hand, is likely to have his attention directed mainly to considerations of the probable running cost of his appliances; while to the nation, vitally interested in the conservation of natural fuel resources, the expenditure of energy estimated in terms of initial coal consumption may probably be regarded as the most important aspect.

Although a certain degree of warmth may be desirable for the preservation of furniture, hangings, etc., the ultimate aim in warming a house is generally the comfort of its occupants, and it is this phase of the problem with which we shall chiefly concern ourselves. The influence of environment upon man's bodily and intellectual energy has long been recognised. Aristotle pointed out that extremes of temperature were prejudicial to mental activity, and that in very high or very low latitudes great achievement was rare, whether in the Arts or Sciences; Vitruvius, too, commented upon the bearing of climate upon racial characteristics. And recently, we have Huntington*, whose investigations into the relation between environment and health are well known, declaring that man's mental and physical welfare depend more upon climate than upon any other single factor, and that the contrast between the energetic peoples of temperate zones and the lazy and sluggish inhabitants of the tropics is to be attributed mainly to the dissimilar physical characteristics of their habitats. Since, however, many other factors likely to affect man, *e.g.*, the nature of his available food supplies, are themselves governed largely by climatic conditions, indirect regional effects must not be overlooked.

Weather conditions may be expressed approximately in terms of the temperature, humidity and movement of the air and the intensity of sunshine. We have, as it were, a vast natural heating system, in which the sun plays the part of a radiator, and ventilation is furnished by the winds; but it is a system almost entirely outside human control. It is not, however, impossible to conceive of some mimic installation whereby the absence of sunshine over a given area might be compensated for by an equivalent emission of energy from giant radiators in the sky, and the condition of the air suitably modified by specially arranged devices. But it would be beyond the power of man to put such an ambitious scheme into operation, and he must be content to produce his artificial climate upon a very diminutive

* Huntington and Cushing: "The Principles of Human Geography" (2nd Ed., 1922), p. 248.

scale, namely, inside his dwelling place. Even here, the attempt to create comfortable conditions is frequently limited to a single room, or perhaps only to a corner of a room; but in most civilised countries the "indoor" environment is, to some extent, regulated artificially, and modifies the effects of the natural climate upon physiological reactions. The maintenance of proper standards of heating and ventilation thus gains an added significance, especially as many of us are by force of circumstances obliged to spend the greater part of our time in indoor occupations.

Man was, of course, familiar with the use of fire long before he concerned himself with any conjectures as to its possible hygienic advantages either to himself or to his race. He was led to warm his dwelling for the sake of comfort and convenience, and in very early days he already made use, as best he could, of the rough means of artificial heating at his disposal. Doubtless, he calculated the cost of the labour involved in fetching and carrying his fuel, or in making his fires; while it is easy to picture the concern of a chief at any unnecessary depredations into the fuel supplies of his own particular territory.

Far back in prehistoric times, material evidence of the use of fire has revealed itself in the form of charcoal or fragments of burnt pyrites, and rough cooking appliances have also been discovered. Fire was produced by rubbing together pieces of wood or by striking flints or pyrites, while wood, grass or other vegetable refuse was doubtless the usual fuel. This, piled up in some opportune spot, in the open air or on the floor of a cave, formed a rude means of combating cold, such as is still practised by savages or nomadic tribes, or by civilised man himself in wild surroundings.

When people began to congregate together in communities and built groups of huts, the fire was brought into the dwelling place. The Saxons, for instance, constructed houses of timber, with the fire built up against a hob of clay in the middle of the earthen floor, a hole in the roof or unglazed windows serving as a smoke outlet.

In some of the castles built during the days of the Norman occupation, the fireplace is no longer found in the middle of the hall, but is removed to an exterior wall, with a short, slanting flue—the forerunner of the chimney as we know it—leading through the thickness of the wall to the outside. Chimneys proper were not introduced into this country until about the 13th century. Subsequently they were often treated as important architectural features; but it was only very gradually that the central hearth gave way to the recessed fireplace and chimney, even in buildings of considerable pretensions. The change was, in fact, deeply resented by the dependent classes, for it became the custom of the lord and his lady to sit in a private room, instead of mingling as in the past with their retainers around the great hall fire. Langland, in Piers Plowman, says:—

"Elynge is that halle eche day in the wyke
There the lorde ne the lady liketh nat to sitte
Nowe hath eche ryche a rewle to eten by hym silve
In a privey parlour for pore mennys sake;
Or in a chaumbre wyth a chymney and leve the cheef halle
That was made for melis man to eten inne."

Wood was still the general fuel, although there is documentary evidence that coal was employed so early as the 9th century, and mining is known to have been carried out systematically in the 12th century. Subsequently, the use of coal for industrial purposes grew to such an extent in London that a Royal proclamation was issued in 1306, forbidding its use on the grounds of its "noisome smell." But in succeeding centuries, the price of wood gradually became very high, as the great forests dwindled before the agricultural requirements of a growing population; and in spite of recurrent outcries against the smoke nuisance the amount of coal used continued to increase. In 1700 the total annual output of coal in the United Kingdom had reached about three million tons; by 1800 it had increased to some ten or eleven million tons. But it was not until the development of canal navigation towards the end of the 18th century, and the later introduction of railways, that the new fuel was adopted generally for household purposes; and even to-day many rural areas remain in which wood or peat is burned on hearths of primitive design and coal is rarely seen. At the present time, the domestic consumption alone amounts to about 40 million tons a year, the total output to over 250 million tons.

The vast mediæval hearths, in which iron stands, or "andirons," supported great logs of wood, were soon found to be unsuitable for the burning of coal, and as its use became more general, they underwent gradual modification. At first, large iron grates, generally of the movable "dog-grate" type, were introduced into the existing hearth openings, but later on the width of the chimney recess itself was reduced by means of metal plates and hobs, between which, raised up from the hearth, the grate was fixed. During the 19th century, firebrick was gradually substituted for metal in the construction of the sides and backs of grates, the cross section of the chimney throat was reduced, and the custom of tiling the hearth recess was introduced. About half-a-century ago, the low-set grate, with slender front bars and overhanging firebrick back made its appearance. The space beneath the firebed was closed in by means of a small, closely fitting fender—generally provided with adjustable air inlets—and the slits in the grating were narrowed. Such grates, variously modified, have now almost entirely replaced the old-fashioned high grate, with its clumsy bars and unrestricted bottom draught.

Meanwhile other developments were taking place. Bonnemain's system of low pressure hot water heating was introduced into this country in the

19th century, and made rapid headway. The use of central heating has since become very general for large buildings, hot water from a central boiler—generally coke-fired—being led through specially designed arrangements of hollow metal columns, wrongly known as "radiators," suitably disposed in rooms and corridors. Alternatively, methods have been developed whereby buildings may be heated by circulating through them air which has previously been warmed by contact with some convenient surface, such, for instance, as a furnace casing or electrical resistances.

The late 18th century saw the beginnings of the distillation of coal for the production of gas, soon to be followed by the formation of commercial gas undertakings. The new fuel was applied mainly to illuminating purposes, but its possibilities as a source of heat were soon realised. The early gas stoves were crude, dirty and unpleasant, but steady improvement followed the introduction of the Bunsen burner in the middle of the 19th century. At the beginning of the present century, gas fires with tubular radiants, each heated separately by its own flame, were introduced, steps were taken to ensure the complete removal of the products of combustion by way of the flue and to promote an adequate rate of ventilation through the room, and the silent flame was perfected. In consequence, the use of gas for heating purposes has since extended with considerable rapidity.

More recently, electric heating has come into prominence. The first electric heaters were of the glow lamp type, but these are low rated and somewhat bulky; and since the introduction, early in the present century, of non-oxidisable high resistance nickel-chromium wires, which can be maintained at very high temperatures in air without appreciable deterioration, the open type of electric heater has rapidly developed. This consists of long lengths of fine resistance wires wound on porcelain, mica or fireclay bars—usually known as "elements"—suitably mounted side by side in metal frames in such a manner as to present a bright incandescent surface to the room. Numerous other types of electric heaters, however, are available, and can meet almost any given heating requirement.

In this country, where natural gas and natural oil are practically non-existent, and where water power resources capable of economic development are very limited, we are likely for an indefinite period to be dependent for both heat and power production upon coal and its derivatives, including gas and electricity. The expenditure of energy entailed in the use of any given fuel must consequently be considered in relation to the initial coal consumption involved in its production.

At the present time, notwithstanding the advances which have been made by gas and electricity for household use, domestic heating is still carried out mainly by the burning of raw coal in open grates. Unfortunately, under such conditions, no means are available for collecting the by-products of the coal; some of them burn, but the extent to which they escape com-

bustion is plainly evidenced by our smoky chimneys. Most authorities are agreed that, in view of the accompanying waste and damage, such a state of affairs is greatly to be deplored, and that the proper course would be to subject all raw coal to some form of preliminary treatment, whereby either the by-products might be preserved or the smoke producing constituents eliminated, or both.

Such conditions are fulfilled by the process of coal carbonisation carried out at the gas works, with the production of coke, gas, tar and other useful products, from which a great diversity of everyday commodities, such as dyes, drugs, disinfectants, fertilisers, etc., can be prepared by the chemist's skill. The British gas industry at the present time deals annually with about eighteen million tons of coal, which yields nearly 300,000 million cubic feet of gas. The greater proportion of this, however, is absorbed for lighting, cooking and general industrial purposes.

By employing coal as a source of power for the generation of electricity, energy which can be utilised without the production of smoke or dirt is rendered available, but in this case the by-products of the coal are not recovered. Nearly eight million tons of coal are used annually in our power stations, with a production of about 7,500 million Board of Trade units of electricity.

Unfortunately, when coal is subjected to any transformation process whereby its energy is converted into some other form, a thermal loss is unavoidable. In gas manufacture, for instance, some of the coke made must be reserved for heating the retorts, and there are slight leakages of gas both in manufacture and in distribution. Such causes represent an aggregate thermal loss equivalent to some 20-25 per cent. of the potential heat value of the coal treated. The thermal value of saleable gas does not as a rule exceed about 25 per cent., whilst saleable coke is 45-50 per cent. and tar 5 per cent.

For many purposes, gas coke is a satisfactory substitute for raw coal; and if we assume that convenient outlets are to be found for all the coke produced, the effective weight of coal expended in the gas making process may fairly be regarded as only about 50 to 55 per cent. of the actual amount dealt with, *i.e.*, as the total amount, less available gas coke. Since on this basis of calculation, gas with a potential heat value of 25 therms may be considered as the return from a net expenditure of 50 to 55 therms in solid fuel, the thermal efficiency of the conversion of coal into gas becomes 45 to 50 per cent., or, taking account of tar, 50 to 55 per cent. These are the figures upon which we must base calculations of the inroads into our national fuel supplies consequent upon the substitution of gas for solid fuel.

The thermal loss occasioned in the carbonisation of coal must be compensated for in the balancing of income against expenditure by an increased return for the products in relation to the price paid for raw coal. Overhead

and labour charges, and interest on capital invested, must also be met. The value of gas coke as a fuel is not such as to enable it generally to bear any great share of the resultant burden; and, in consequence, the price of gas reckoned on a thermal basis is always much higher than that of coal. At the present time, a high grade household coal may be bought for 1.7 to 2.1 pence per therm (45-55 shillings per ton); gas coke for, say, 1.5 to 1.9 pence per therm (35-45 shillings per ton); and coal gas for 8 to 12 pence per therm. These are the figures upon which estimates of running costs to the householder must be based.

The thermal waste associated with the generation of electricity from coal is far more serious than that consequent upon carbonisation, but, on the other hand, it is possible to make use of lower grade coals. There is however, a loss in the conversion process amounting in the aggregate to about 87 per cent. of the initial heat value of the coal used; or, as it is generally expressed, the thermal efficiency attained in power stations dependent upon coal averages only 13 per cent. For the most efficient stations, the figures rises to 20 per cent. Such a shrinkage of the raw material is bound to result in a very highly-priced product; and, as a matter of fact, except in such cases as those in which advantage can be taken of a special tariff, about 59 pence per therm (2d. per Board of Trade unit), is the average price paid by the householder for electricity applied to heating purposes.

It follows that at the prices quoted the costs of a given number of potential heat units in coal, gas or electricity are in the ratio of 1 : 5.3 : 31, while the amounts of coal involved in their production are in the corresponding ratio of 1 : 1.9 : 7.7. Since, however, it is never possible in practice to utilise the whole of the energy theoretically available, but only a proportion which is far less for coal than for either gas or electricity; or, in other words, since the "efficiency" of heating appliances adapted to the burning of coal is much inferior to that of gas or electrical alternatives, the above figures must be considerably modified in order to arrive at a true comparison of the relative costs of equivalent heat production.

There are, moreover, many different aspects from which alternative methods of heating may be considered; and since we are concerned not always mainly with the quantity of heat available for the warming of a house or a room, but more often rather with the comfort of its occupants, it does not necessarily follow, as we shall see later, that computations based on equal heat production will be indicative of the actual needs. The problem before us, in fact, becomes intelligible only in the light of a knowledge of the nature of the heat requirements of a civilised human being; and before reviewing in detail the relative merits or demerits of the different methods of artificial heating at our disposal, it will be convenient to consider briefly this attendant question.

Man is a warm-blooded creature, whose internal temperature, whether the environment be warm or cold, is maintained automatically, by the oxidation of foodstuffs in the tissues of his body and by the action of certain natural heat regulating devices, at a uniform value of about 98° F. Why, then, should his physical comfort be related to his surroundings? The answer is to be found in the fact that although the interior body temperature remains practically constant, the temperature of the skin varies with the physical conditions of the environment and with the insulating value of clothing; while, on the other hand, sensations of heat or cold are governed by the varying difference between surface and deeper blood temperatures, comfort usually being associated with a skin temperature of about $91\frac{1}{2}$° F.

Since this is a good deal in excess of the temperature of any ordinary room, heat escapes continuously from the body to its cooler surroundings, both by radiation, convection (or warming of the contiguous air) and evaporation from lung and skin surfaces. The rate of heat loss is controlled to some extent by the automatic devices to which reference has already been made, but it also varies with the character of the surroundings. The emission of thermal radiation, or in other words, of rays which, when intercepted by any obstacle, are transformed into heat, is a property common to all bodies, whatever their temperature. The intensity of the radiation emitted, however, increases with the temperature; it is also related to the nature of the surface, both emission and absorption being least for highly polished metallic surfaces and greatest for dull black surfaces. Hence, a system of exchanges operates, in which the net rate of heat loss by radiation is measured by the difference between energy emitted and energy absorbed from neighbouring surfaces. This has been shown to be given by the expression $16E \times 10^{-10} (T^4—t^4)$ B.Th.U. per square foot of exposed surface per hour, where E is its emissivity in terms of maximum ("black body") emissivity, T its temperature and t that of surrounding surfaces, in degrees F. absolute. The rate at which heat escapes from a body by convection, or by the air currents rising from it, may be calculated in B.Th.U. per square foot per hour from the expression $C (T—t_1)^{5/4}$, where T is the temperature of the exposed surface, C is a constant which varies with its size, shape and position, and t_1 the temperature of the surrounding air. In practice t and t_1 are frequently, but not necessarily, nearly equal. The emissivity of the human skin when normally dry has been shown to be about 90 per cent. that of a perfectly black surface, and a value of about 0.30 may be assumed for C.*

When seated at rest, a man breathes some 15 cubic feet of air an hour, which is exhaled at about 93° F., and saturated with moisture. The amount of heat which this process extracts from his body varies with

* See Griffiths and Davis, "The Transmission of Heat by Radiation and Convection," Food Investigation Board, Special Report, No. 9.

the condition of the air breathed. Saturated air at 93° F. would obviously take up little further heat, while air at 65° F. and 50 per cent. of saturation would absorb about 40 B.Th.U. per hour, and perfectly dry air at freezing point over 50 B.Th.U. per hour. In general, the colder and drier the air breathed, the greater is the amount of heat which it absorbs in its passage through the lungs. Surface evaporation, on the other hand, is practically inoperative in cool surroundings, for the skin then remains relatively dry; but as the temperature rises, the rate at which the sweat glands supply moisture to the skin increases automatically, and so controls the rate at which evaporation can take place. In very hot surroundings the skin is kept continuously warm and damp, and evaporation is then related to the vapour pressure of the surrounding air, its rapidity decreasing with increasing vapour pressure, and approaching zero as the vapour pressure approaches the value for saturated air at body temperature.

Since, for health, the temperature of the body must remain at a uniform level, it is clear that the aggregate rate at which heat escapes from it must be equivalent to the internal heat production. This condition is fulfilled automatically (*a*) by regulation of the effective insulating value of the skin brought about by variations in the cutaneous circulation, and by the control of the sweat glands ("physical regulations"); (*b*) by changes in the rate of internal heat production ("chemical regulation"). Most physiologists are agreed that the rate at which heat is generated remains constant within certain limits of variation in the environmental conditions, uniformity of body temperature over this range being secured by physical regulations alone. But in either very hot or very cold surroundings, the heat production is accelerated.

As is well known, muscular exercise or the performance of mechanical work induces intensified heat production, the increase in this case bearing no relation to the conditions of the surroundings. As a rule, only about 25 per cent. of the energy expended is accounted for by work done, the remaining 75 per cent. appearing internally as heat and generally occasioning increased skin evaporation. The quantity of heat produced by a sedentary worker varies with his surface area and is modified by the conditions of living, but an average subject generates about 375 B.Th.U. per hour. A manual labourer, during the period of his exertions, may produce two, three, or even four times this amount, but such severe drains upon his energy could not be sustained for indefinite periods without exhaustion.

Under ordinary indoor conditions, some 45 per cent. of the body heat is dissipated by radiation and 30 per cent. by convection. Lung and skin evaporation, together, carry away only about 22 per cent., of which the effects of breathing account for half or more according to the degree of saturation and the temperature. Under such conditions, therefore, skin evaporation is a relatively insignificant means of heat loss, and subject to

little further reduction. Thus, as the temperature of the surroundings is reduced below, say, 60° F to 65° F., evaporation soon reaches practically a minimum value, while radiation and convection, in spite of restricted cutaneous circulation continually increase; consequently, chemical regulation is called into play, whereby the rate of heat production is so modified as to balance the increasing heat losses. On the other hand, as the temperature of the surroundings increases above 60° F. to 65° F., there is a slight attendant increase in the temperature of the skin, but since this is not enough to prevent a steady diminution in the outflow of heat by radiation and convection, a compensating acceleration of evaporation, evidenced by sweating, is induced. Extremes of heat or cold, however, put a great strain upon the human mechanism, and prolonged exposure to either may lead to failure of the regulating system. We seek to combat them by adjusting the artificial insulation of the body by modifications in the amount of clothing worn, and by variations in diet.

It may be gathered from the figures which have been given, that at moderate temperatures, when radiation and convection provide adequate heat outlets, the humidity of the air in a room may vary over a wide range without greatly affecting the comfort of sedentary workers; but at high temperatures, when radiation and convection are diminished, or for manual work when heat production is accelerated, a relatively low humidity is desirable. Very dry air, however, is usually considered injurious to the delicate mucous membranes of the nose, throat, etc.

The purpose of house heating is to maintain such environmental conditions as may allow uniformity of body temperature to be preserved without undue strain upon natural thermostatic controls, or more simply, to sustain comfort. How, then, are such conditions to be defined? It is common knowledge that a temperature of some 62°F.-66°F. is required for continued sedentary work, although for short periods somewhat cooler surroundings may be found comfortable, while in moving air higher temperatures are required. We have seen that in the first case some 75 per cent. of the body heat, or, say 280 B.Th.U. per hour, is dissipated by radiation and convection. Calculation shows this to be consistent with a surface temperature of about 75°F., which is the value obtained by Rubner from actual measurements. If now we could imagine the walls of the room and other surrounding surfaces also raised by some means to 75°F., the net radiation losses from the occupants would be reduced to nil, as the clothing surfaces would receive radiation from the surroundings at the same rate as they themselves emitted it. Thus, unless sweating came into play (which would require a skin temperature too high for comfort), such an increase in convection as would account for the deficiency would have to be induced. To bring about such a result, calculation shows that it would be necessary to reduce the air temperature to about 50°F. Thus, with walls and other adjacent surfaces at 75°F., and

air at 50°F., a room would presumably feel comfortably warm to sedentary workers in ordinary indoor clothing. It may be shown that a similar result could be effected with air at 64°F. by increasing its velocity through the room to about 4 feet per second. If the temperatures of the interior surfaces of the room were in excess of 75°F., clothing surfaces at 75°F. would absorb radiant energy more rapidly than they emitted it, and consequently still lower air temperatures, or still higher air velocities, could be borne without any sensation of chilliness. Alternatively, as the walls and other surfaces fell from 75°F. to 64°F., the air temperatures associated with comfort in the absence of any considerable draught would rise from 50°F. to 64°F.

When a relatively small area, such, for instance, as an open fire, is maintained at a very high temperature in a room, a far more complicated state of affairs is set up; for in this case, clothing surfaces take up temperatures which vary with their position in relation to the fire. Some parts of the body may consequently be gaining heat, while parts remote from the fire are losing it. The colder the air in the room, the greater must be the absorption of radiation to balance its cooling effects. Thus, if the air is very cold and the fire small, it may be necessary to approach so closely to it that a sensation of scorching is produced locally while parts of the body turned away from the fire feel chilly. It may be inferred that in very low air temperatures, if warmth is to be sustained without an increase in the amount of clothing worn a considerable area of the body should be exposed to radiation.

We have now the key to the fundamental principles of artificial heating, all methods of which we shall find can be divided roughly into two classes. The first of these comprises the various systems in which pre-heated air is admitted to a room, or in which the heating appliances are of such a form and at such a temperature as to act mainly by the emission of warmed air, and which, therefore, owe their effect upon the rate of body heat loss primarily to a reduction in the convection flow. The second class embraces the numerous different devices whereby some surface in occupied rooms is maintained at a temperature high in relation to that of the air. Such appliances are designed primarily to reduce the net rate at which the body loses heat by radiation. As has already been seen, either small surfaces at very high temperatures or more extended surfaces at lower temperatures may be utilised for this method of heating. The effects of unavoidable high temperatures can be countered to some extent by increasing the air movement by means of fans or other suitable devices, or by reducing the amount of clothing worn.

The essential dissimilarity between the action of air heating and radiation heating is a great stumbling block to any precise comparisons of methods which fall into different classes. For while with air heating all parts of a room are nearly equally comfortable, with radiation heating comfort depends entirely upon one's proximity to the fire. Or, put otherwise, with air heating,

the whole of a room, even though it may be large and have only a single occupant, must be brought to a comfortable temperature; but with radiation heating, even in a large room, a small fire may suffice for the comfort of a single occupant, provided that he can get near enough to it.

In practice, heating appliances, by means of which the air of a room is warmed, inevitably exert also a slow, gradual warming effect upon the walls, ceiling, carpet, furniture, and other objects with which the air comes into contact. On the other hand, methods utilising a high temperature radiating surface always bring about a certain degree of air warming as a secondary effect. The air does not itself absorb radiant energy, but absorption of radiation leads to a gradual warming of the contents of the room, which then communicate heat by convection to the neighbouring air. There are many appliances, also, which belong to both classes, such, for instance, as anthracite stoves or steam pipes, which consist of heated surfaces that not only warm the air directly by convection, but also emit a good deal of radiation. Most convection heaters, in fact, give a small proportion of direct radiation, and most radiation heaters a small proportion of direct air heating.

We have seen that in the absence of any surface at a relatively high temperature rooms must be maintained at about 64°F. to keep sedentary workers warm, and that considerable variations in the relative humidity will not then have any noticeable effect upon sensations of comfort. If there is any appreciable air movement in the room convection losses from the body will be increased and either higher temperatures (about 69°F. is optimum for a draught of 2 feet per second, 72°F. for 4 feet per second, and 75°F. for 6 feet per second*) or compensating radiation will be required. Experiment has shown that undesirable conditions are created when the walls of a room are relatively cold, even though the air may be warm enough to prevent any sensation of cold. High air temperatures are, in fact, nearly always disliked by people in this country, and tend to induce a feeling of stuffiness and lack of mental energy even while a room is still slightly chilly. It is probable that moving air in conjunction with radiation is healthier than warm still air, but even in an overheated room strong local currents of cold air along the floor are disagreeable. L. Hill has stated that it is of first rate importance that the air at head level should be relatively cool, and that warm feet with ample ventilation at breathing level is the ideal to be striven for. An open window is the best source of fresh air except in very cold weather, and the sun the best source of radiation, but we are often compelled to make use of substitutes.†

* See Fishenden, "The Heating of Rooms." Fuel Research Board, Technical Paper No. 12. Also E. V. Hill, "Aerology for Amateurs and Others," American *Heating and Ventilating Magazine*, January, 1923.

† See "The Science of Ventilation and Open Air Treatment," Part I, Medical Research Committee Special Report Series No 32, p, 145; Also Ditto Part II, Medical Research Council Special Report Series No. 52, pp, 275 and 281.

The quantity of energy which is absorbed in keeping a room warmer than its surroundings depends not only upon the volume of air passing through it, but also upon the rate at which heat escapes by conduction through the walls, windows, doors, etc. With an outside temperature of 30°F., two changes of air per hour could be maintained at 64°F. in a perfectly insulated room 15 feet long by 14 feet wide by 9½ feet high (2,000 cubic feet capacity) by the utilisation of less than 2500 B.Th.U. per hour. In practice, owing to conduction leakages an additional amount of heat, generally equivalent to that needed for warming from one to four complete changes of air per hour, according to the size, construction and position of the room and the weather conditions, is required to maintain the temperature at the desired level. For a room of the size taken, if we assume that there are two outer walls of 9in. plastered brickwork, with 40 square feet window space, conduction losses would amount to about 4000 B.Th.U. per hour, even were all adjacent rooms at 64°F., and heat flow in their direction therefore eliminated. Perfect insulation is, of course, not attainable, but considerable improvements may be effected by proper building methods, and in the interests of fuel conservation it is of importance that these should be observed.*

Convection heating, with no primary radiation, can be obtained by the introduction of pre-heated air into rooms. The most familiar example, however, although in this case accompanied by a small proportion of radiation, is afforded by the usual system of central heating in which so-called radiators, consisting of groups of interconnected cast-iron columns through which hot water from a central boiler circulates, are installed in the rooms and corridors of a house. These are usually maintained at a temperature of about 160°F. Cast-iron, or any ordinary painted surface at this temperature, if freely exposed in still air at 64°F., emits radiation equivalent to about 95 B.Th.U. per square foot per hour, and spends a further 90 B.Th.U. in warming the air which rises from it. For a bright metallic surface, such as one coated with aluminium or bronze paint, the radiation emission would probably be reduced to about 60 or 70 B.Th.U. per square foot per hour, convection remaining unaltered. But owing to the special design of the ordinary sectional radiator, in which the columns are packed closely together in order to get a large total area into a small wall space, the heating surfaces are in such close juxtaposition one to another that much of the radiation which they emit is obstructed, and only a small proportion, say 10 to 20 per cent., finds its way into the room. The total emission of energy for the given temperature difference is thus reduced to some 100 to 110 B.Th.U. per hour, according to the nature of the surface, or slightly more for very short radiators, in which the effective radiating surface, which includes the ends, is greater in relation

* In especial, due attention is not usually paid to the effects of the surface of a material upon its insulating value.

to the total. For a single-section single-column radiator, the total emission would approach 185 B.Th.U. per square foot per hour for a painted surface, or 155 B.Th.U. per square foot per hour for an aluminium or bronze surface. Polished copper radiators would give practically no radiation, whatever their shape or position.

For central heating, no fuel can compete with coke in economy, whatever the basis of comparison. Small coke-fired boilers, such as are used for small-scale radiator installations, give an efficiency of about 50 per cent. in water heating; in addition convection from the exterior stove surfaces may be usefully employed if the warm air has access to the building. In such boilers, neither coal nor anthracite can do much better than coke, and either is dearer per therm. Gas, for air heating, whether through the medium of radiators or stoves, or directly from open flames, gives efficiencies of 80 to nearly 100 per cent., the former figure applying to small gas boilers, the latter to flueless gas heaters of any type. Electrical methods also give practically 100 per cent.

We have already seen that at the present time the prices of equivalent numbers of heat units in coal, coke, gas or electricity are in the ratio of 1 : 0.9 : 5.3 : 31. Assuming 100 per cent. efficiency for gas or electricity, and only 50 per cent. for coal or coke, the cost to produce any given effect becomes 1 : 0.9 : 2.6 : 15.5. Or, in other words, gas is nearly two-and-a-half times, electricity fifteen-and-a-half times, as expensive as coal, while coke costs rather less than coal.

On the basis of initial coal consumption, since the destruction of coal equivalent to two therms is involved in the production of one therm in gas, there is little to choose between gas and coal. Electricity, however, is very extravagant from this point of view, as it is produced from coal with so low a thermal efficiency that its potential heat value, as we have already seen, represents, on the average, only one-eighth that of the original coal, while its efficiency in use in the case under consideration is only doubled as compared with that of solid fuel. Thus, for continuous air heating, the use of electricity would quadruple the effective coal consumption; or, taking the best station running, where the thermal efficiency of generation is 20 per cent., would more than double it.

There are few instances where extra convenience or reduced labour would be regarded as adequate compensation for such serious discrepancies in cost to the householder as are found between raw coal and gas or electricity for central heating purposes; and it may be concluded that in this case the derivative fuels cannot compete against the parent coal. It will be seen later that they are better adapted to intermittent heating, particularly in certain special circumstances.

A very interesting example of central heating by the agency of direct radiation is to be found in the system known as "panel heating," which at

the present time shows some signs of development. This method depends essentially upon the maintenance of a relatively large patch, such as a ceiling or wall, at a temperature (say, 80°F. to 120°F.) not greatly in excess of that of the remainder of the room, by the circulation of hot water through pipes buried in the plaster.

When the ceiling is chosen as the heating surface, convection currents are largely checked, for the warmed air is already at the highest level attainable in the room, and can rise only through accidental cracks and crevices. The heating effect is thus occasioned in the first instance almost entirely by non-visible thermal radiation; but this is subsequently absorbed by the contents of the room, and air heating ensues. When a wall is chosen as the heating surface, direct convection effects are added to the effects of radiation.

Panel heating has been applied to a number of large buildings, both in London and elsewhere, and is claimed, probably not without foundation, to be both cheap and extremely comfortable. The speaker has found, by direct experiment, that a mean horizontal component of thermal radiation, approximately equivalent to about 30 B.Th.U. per square foot per hour across the position of occupants, is enough to sustain warmth indefinitely in a room at 60°F.; while in a room at 50°F. 120 B.Th.U. per square foot per hour is required. Such an intensity of radiation would be received directly opposite the centre of large surfaces of emissivity 90 per cent, maintained at 93½°F. and 163°F. respectively, in surroundings at the temperatures specified. Taking the former case as an example, in relation to a room of 2,000 cubic feet capacity such as that already dealt with for hot-water radiator heating, it may be computed that the maintenance of two changes of air per hour at 60°F. would entail an absorption of about 5,800 B.Th.U. per hour. This amount of heat would be emitted, by radiation and convection together, from 105 square feet of wall space, or rather less than one of the smaller walls, at 93½°F. With such an allowance, practically all parts of the room would be comfortable.

Since the 6,500 B.Th.U. per hour previously arrived at as the quantity of heat needed to keep the room at 64°F. was calculated on the assumption that the adjoining rooms were warmed to the same temperature, it may, in the present comparison, be assumed that any heat which passes from the buried hot-water pipes through the walls to adjacent rooms will be usefully employed. On such a basis of comparison, the cost of panel heating in this case should be about 58/65, or 0.9, times that of hot-water radiator heating.

In a similar way, about 17 square feet of wall surface at 163°F. would emit the 3,900 B.Th.U. per hour required to keep the general temperature of the room at 50°F., and would give in positions directly opposite its centre the correct intensity of radiation (120 B.Th.U. per square foot per hour) to maintain comfort at this temperature. There would now be sufficient room in the comfort zone for a single occupant only; but sitting close up against

the specified wall surface, say 6 feet high by about 3 feet wide, he should be warm enough, and the cost would be only 39/65, or 0.6 times that of keeping the whole room at 64°F. for his use alone.

The above figures must be taken as no more than the broadest approximations, but they give a useful indication of the order of the quantities involved in panel heating, and of the relatively low temperatures which suffice. They suggest, further, that more extended surfaces might be better than the usual designs of hot-water radiators, although their removal to inner walls might be entailed in order to avoid increased losses to the outside. Alternatively, the back surfaces might be coated with bright metallic paint, to minimise radiation in directions away from the room.

From considerations of panel heating we may also deduce an idea of the mode of action of such appliances as closed coke or anthracite stoves, which present a moderately hot radiating surface, fairly extensive in area, especially for stoves standing well out into the room. The air passing through the fire abstracts heat which is carried away up the flue, and there is bound to be some further loss in unburned products, but far better control of the combustion can be effected than is possible in the case of open fires, and the aggregate efficiency of such stoves has been stated to be about 50 per cent., which, as we shall see later, is twice that of open fires. The relative proportions of radiation and convection will depend upon the construction and placing of the stove, and upon the state of combustion; but for a surface temperature of only 200°F. radiation and convection would be approximately equal, and for higher temperatures the relative amount of radiation would increase. It must, therefore, be borne in mind that the low radiating value of anthracite stoves is due rather to the low rate of consumption required than to any diminution of the radiation efficiency as compared with that of open coal or coke fires. True, the radiation is less intense, but the radiating surface is considerably extended; and its effect in positions nearby should allow of a reduction in the room temperatures needed for comfort. To this extent, assuming the efficiencies on the basis of equivalent heat production similar, closed stoves may be slightly more economical than hot-water radiators especially should the boiler of the latter be in an outhouse and the heat given off from its surfaces not made use of in the house.

The most familiar form of the small-area, high temperature heating appliance is the ordinary open coal fire. This depends primarily upon the emission of radiant energy, partly because the incandescent fuel reaches very high temperatures and partly because the heated air which rises from it is carried away up the chimney flue with the products of combustion of the coal, and so fails to be utilised in the room. Further losses of heat are caused by incomplete combustion and conduction through the flue and grate walls, with the result that the quantity of energy which finds its way into the room does not usually exceed some 20 to 25 per cent. of the total theoretical

energy of combustion of the coal, or perhaps 25 to 30 per cent. when good quality coke is used. The radiation efficiency of commercial grates burning coal generally lies between 15 and 25 per cent. though deeply recessed dog grates with low overhanging canopies and high kerbs, or grates which are very wide from back to front, may give lower values. In addition there is a gradual creep of heat from the hot flue through the wall into the room, but this does not generally amount to more than a very small percentage of the heat of the coal used.

Up-to-date gas fires on the other hand, give thermal radiation into a room equivalent to as much as 50 per cent., or more, of the theoretical heat of the gas used, and a total efficiency of perhaps 55 per cent. Electrical heaters give nearly 100 per cent. efficiency, the proportion of radiation depending upon the type, but rising to 70 per cent. or more in some cases, while the remainder of the available energy is spent directly in air heating.

Taking these figures, it may easily be calculated that on the basis of equal heat production in a room, gas fires are about twice as dear and electric heaters about seven times as dear as coal fires. Coke is slightly cheaper than coal, say about three-quarters the cost. Thus the cost of gas is again very high, while that of electricity is quite prohibitive, in relation to that of coal. There are, however, many cases in which this unfavourable comparison is considerably modified, since it is not for continuous heating that gas or electricity shows to advantage. For intermittent heating, the fact that either can be turned on or off at will results in a substantial reduction in the amount of heat required as compared with that necessary from a continuously burning coal or coke fire. Let us suppose, for instance, that a room—a dining room, say—is used intermittently for a total of four hours a day. Assuming that a gas fire or electric radiator would be kept in action only for the net periods during which the room was occupied, and disregarding the fact that when the heating is discontinuous the temperatures attained in the room will be lower than when a fire is kept burning all the time, the cost of gas or electricity may be taken as proportional to the aggregate period of use. If, to meet the needs of the case, a coal fire must be maintained for 16 hours a day, even though the rate of combustion were cut down to one-half when the room was unoccupied a demand equivalent to a full rate over ten hours would have to be met. On the other hand, gas or electric heating would extend only over the four hours of actual occupation. Thus, the cost of gas would be reduced to about 0.8 times the cost of coal, or about the same as that of coke; while electricity would cost about three times as much as coal. Moreover, electric heaters are portable, and the fact that they can be placed in any convenient position often enables them to keep the occupants of a room comfortable by the emission of less radiant energy than would be required from a more distant coal fire. Since the use of solid fuel involves a great deal of work, both directly in the laying of fires, carrying of coal, cleaning of grates and sweeping

of chimneys, and indirectly through the effects of dirt, gas fires for periodic heating totalling only a few hours a day generally prove in practice decidedly cheaper than coal or coke fires. And even electric heaters, by their convenience and adaptability, sometimes repay for the higher cost of the units used. Where energy can be obtained for less than 1d. per unit, electricity may be regarded as a serious rival of coal for intermittent heating.

Since the thermal efficiency of the making of gas from coal is about 50 per cent., and the resulting gas can be utilised in an open fire with more than twice the efficiency of coal in an open grate, from the aspect of coal conservation gas fires compare satisfactorily with open coal fires even for continuous heating. For intermittent use, their substitution would be accompanied by a great saving of our natural fuel supplies. The high efficiency in use of electric heaters again fails to compensate for the low thermal efficiency of generation, and for continuous heating their use in place of open grates would result in nearly twice as much coal being used at the power station as would suffice if burned directly in a room. If only required for a few odd hours, however, the position may become so far modified as to allow of a slight reduction in effective coal consumption.

Since open coal or coke fires burn up slowly, the radiation emitted is low in the period immediately following lighting. This is a serious defect, for, while the rise of temperature in the room is consequently very gradual, it is precisely in the initial stages, when the room is still cold, that most radiation is needed for comfort. In this respect, gas fires or electric heaters score, for they can be turned on at full rate while the room is cold, and subsequently reduced; on the other hand, the fact that they are in use only intermittently causes the initial temperature to be lower than when coal fires are used, and for this reason in very cold weather the temperature of the walls may get so low that a scorching radiation is needed to counterbalance their effect. As a rule, if one can conveniently get within 5 or 10 feet of a coal fire burning 2 lbs., a gas fire burning 30 cubic feet, or a high temperature electric radiator taking 2 kilowatts per hour, room temperatures of 55°F. to 60°F. will suffice for sedentary occupation. At greater distances, very large fires would be required unless some means of warming the air were available separately; and then another trouble arises, for too near the fire it becomes uncomfortably warm.

So far as health is concerned, there are probably real grounds for our national love of the coal fire, which in many ways is a form of heating well adapted to the prevailing climate. The non-uniformity of its effect, although usually accounted a disadvantage, may well actually be stimulating physiologically, and the high rate of ventilation induced is probably also hygienically good. The winter temperatures in this country do not fall so low as to render direct air heating really necessary, though the ideal equipment doubtless includes some form of radiators to be used in conjunction with air heating in very cold weather, or alone during in-between seasons.

I doubt whether we are in a position to state definitely to what extent it would be desirable from the physiological aspect to reduce the air temperatures in rooms with warmed walls; but judging by the effects outdoors of low air temperatures in conjunction with sunshine, it might be considerable. But in any case it would not be feasible to keep the air very cold, for the indirect effect of the energy liberated as radiation would soon warm it up. We do not know precisely to what extent radiation from an incandescent source may have beneficial effects not common to non-visible radiation; nor whether such non-uniformity of temperature as we have, say, in a coal fire, may be desirable. Again, it is not possible to define any precise temperature, humidity, air flow or radiation as necessarily the best for health and comfort; though further investigations into the relation between physiological reactions and the physical conditions of environment might throw light on this point. The most important condition, as Dr. Hill has repeatedly pointed out, appears to be that the body should be able to get rid of the heat which it generates with the least possible strain upon its regulating mechanism, though variety has a stimulating effect upon both mental and physical activity, so long as the extremes experienced are not too severe. Generally speaking, relatively low air temperatures with moderate humidity, ample air change but draughts not exceeding 2 feet per second, and radiation directed downwards to keep the feet warm, partly by direct action and partly by warming the floor, are probably the nearest conditions that can be formulated.

It may be gathered that the problem of domestic heating is a great deal more complicated and difficult than its homely name might suggest. Economy is generally a primary consideration, and the most suitable method of heating to be adopted in any case depends essentially upon the requirements, and is related both to the size of a room and the number of its occupants. As has already been pointed out, where convection heating is used, the whole of a room must be warmed, however large it may be, or whatever the number of its occupants; while with radiation heating, people can gather around the fire, whatever the size of the room. Consequently, for continuous heating in small rooms, air heating is generally the cheapest method, but as the size of the room increases open coal or coke fires become cheaper, especially if there are only a few people present. But for very large rooms, open fires alone become impracticable, and some form of air heating must generally be fallen back upon; it will be interesting to see whether panel heating is found suitable for such requirements.

I have not touched upon the smoke problem, but its most immediately possible solution would appear to lie in the elimination of raw coal from our houses, and its substitution by coke, gas and electricity, each for the purposes to which it is best fitted.

DISCUSSION.

THE CHAIRMAN was sure the audience would feel how wonderfully fair and judicial had been Dr. Fishenden's presentation of the problem. She had been distinguished by a series of most admirable and carefully conducted researches into the matter, and she, and the womanhood of England, could be congratulated on having carried out so excellent a piece of work.

The problem was one of the most important which could be imagined in connection with the health of the population of this country, because by our system of heating and ventilating rooms and factories either the vigour of the English race could be kept up or it could be reduced to the debility and feebleness of a tropical people. People were traditionally brought up to fear cold, but few had the knowledge to fear over-heating and the danger of stagnant air. That danger, it was generally thought, arose from chemical impurity of the air, but every physiologist knew that that had nothing to do with the matter at all, and that in ordinary rooms the chemical purity of the air, so far as concerned carbonic acid and oxygen, did not come into play in the slightest degree. Nor was there any chemical impurity of an inorganic nature which was of a poisonous character given off by the human body, as was so commonly thought. The injury which resulted from stagnant warm air arose from the strain which it put upon the body—upon the heat regulating power of the body and the evaporative power of the body. Then there was the gross pollution of crowded rooms with dust and microbes of infective diseases, such as catarrh and influenza. Infection had not occurred in the trenches in the Great War, when the men were exposed to the most bitter inclemency of the weather. Few pneumonias and colds had ever occurred at the Front. They had occurred in the cities when our sailors and soldiers had come back to crowded stuffy rooms. Children in sanatoria exposed to the open air had a heat production in the winter nearly twice that of an ordinary child. We did not want to reduce the vigour of the English race by over-confinement in heated rooms and by an excessive fear of cold.

It was necessary also to get rid of coal smoke, because it was essential to obtain ultra-violet rays. It was known now that the ultra-violet rays of the sun or of an arc lamp could prevent many diseases—for instance, rickets. It was necessary in order to cure tuberculosis to have sunshine and exposure to cool and open air. Sunshine and open air were cut off far too much in our modern cities. Children were being coddled far too much. Sanatorium curative treatment ought to be applied to everybody as preventive medicine. He need only point out what was happening in the Zoo. After a lecture which he had given to the Zoological Society lamps had been introduced into the Zoo, with the result that animals and reptiles which had previously died during the winter were now thriving and living through the winter. Previously when hot water heated chambers had been adopted the iguanas had all died, but they were now thriving under the visible and ultra-violet rays given off by lamps. Those ultra-violet rays could not be got out of gas or coal fires but they could be got out of the sun and out of arc lamps. We wanted, in our bad winters and under present conditions, to be able to use arc baths. Such baths should be open to the use of the community just as much as water baths were. An arc bath once a week during the winter would make all the difference in the world to a person's health. Hundreds of children could be put through one arc bath a week, the initial cost of which was only £20 or £30.

A coal fire had a very great point in its favour, in that it avoided monotony. He had told every gas authority he had met that their gas fires ought to be made as mobile as possible. One ought to be able to put on anything from two radiants

up to 12 radiants. At present people got over-tired by over-heating themselves with gas fires. A properly flued gas fire did not poison the air in any way at all; it was most efficient in heating, and it gave a red heat which penetrated, but it was too monotonous; it required to be made more mobile. Why should not the architects modify the present form of chimney and institute a spherical gas fire in the middle of a room with a flue into the middle of the ceiling which could be made, if necessary, a decorative cylindrical pillar? That flue, passing under the floor of the room above, would warm it, and people sitting round such a spherical gas fire would get all the necessary radiant heat.

MR. ARTHUR H. BARKER, M.I.C.E., B.Sc., Lecturer in Heating and Ventilating Engineering at University College, London, said he could not help thinking in what a very difficult position physiologists placed heating engineers, who were charged with the duty of determining how much heat was required for a given room under given conditions and in what form the heat was obtained. From what physiologists kept on telling them, heating engineers could not lay down the quantity of heat that they definitely wanted, because the actual quantity required was constantly varying from minute to minute. Heating engineers had to determine definite quantities of heat which were required for each particular case. Therefore, their calculations were foredoomed to failure before they started, because the quantity was not constant but varying. The heating engineer could not vary the quantity of heat which he delivered to a room from minute to minute, because his heating apparatus had such a heavy time lag that it took hours before he could change the rate of heat supplied.

The paper raised some very interesting questions in regard to heat comfort. He said what he was going to say with very great trepidation because he was not a physiologist, and he was in the presence of one of the leading physiologists of the world. He was in the unfortunate position of disagreeing to some considerable extent with opinions which he knew were absolutely well founded, but speaking from experience as a physicist and heating engineer he could not agree with many of the laws which had been laid down by physiologists. His own view in regard to heat comfort was that too much importance had been attached in the past to the conventional balance between heat generated and heat emitted. He had always believed that physiologists disregarded too much the time lag in the operation of the thermo-static mechanism. He was convinced that the variations in bodily temperature must be much greater than was generally believed in the innermost recesses of the body. He could not see how it was possible, from the physical facts which were available, to say that the body could be as uniform in temperature as it was commonly believed to be. In his view it acted as a sort of heat reservoir, and the thermo-static mechanisms were not set in motion by such slight variations in temperature as was usually believed. If it were possible to determine, which it was not, the total heat in the body at any moment, his own view was that it would be found to vary very considerably. It would be very dangerous for him to quote any figures, but he had formed his opinions from a consideration of the physical facts of heat impinging on a body, and what he knew to be the specific heat and so forth of the body, and the consideration of where the heat could possibly go to. It was often exceedingly difficult in heat experiments to strike a balance between the heat which was known to be there and the ultimate destination of the heat. He had been in the Physical laboratory more or less all his life, and he did not think there was any branch of physics from which it was so excessively difficult to produce a reasonably good result as the science of heat. His own personal experience led

him to believe that heat comfort and discomfort were much more a mere skin sensation than anything to do exclusively with calorimetry, as was the general view. For instance, when he was feeling very cold he found that a very slight impinging of a very small amount of radiation, which he knew how to measure, on the surface of the cold skin was enough to dissipate at once the feeling of cold. The small amount of heat absorbed could not affect considerably the general calorimetric balance. Similarly, when one was very warm, if one stood 10 or 15 feet away from a block of ice, it was quite enough to dissipate the feeling of excessive heat. His own view in all these things was that radiation on the surface of the skin had an enormously greater effect on the feeling of heat comfort than was generally supposed.

With regard to the relative cost of gas and solid fuel, it would be of enormous advantage to the health and well-being of the population if gas and electricity as a whole could take the place of solid fuel. He had made close comparisons between the actual cost of cooking a certain standard meal, which he had cooked a hundred times with different appliances, and he had measured very carefully the amount of energy. He could not possibly go into the question that evening of the relative cost, but he had carried out an experiment which had gone further than that. He had wanted to compare the cost of running a house with gas exclusively, with different combinations of gas and coal, and with coal exclusively, and he had induced the London County Council to lend him two of their houses. He had had those houses fitted up with about five gas meters each, one connected to each of the services. He had run a house for a whole year with gas, and had then turned over exclusively to coal, and had then gone in for various combinations. He had not tried electricity, because that had not been on the estate. He had found out, as a result, that in the case of one person living alone, gas was no dearer than solid fuel. It had not cost any more, for equal comfort, to use gas only than it had solid fuel, and there had been enormously less labour involved. He might mention that "The Builder" was going to publish his report on the matter in the course of a week or two. For one person living alone gas, as he had said, was no more expensive in money than was solid fuel, but the same thing would not hold if there were a number of people living in the house. The reason was that when one person alone was in a house only one room was used at one time, and the heat derived from gas could be localised in a way in which solid fuel could not. The efficiency of solid fuel when used under those conditions dropped very much. That did indicate the possibility in certain circumstances of using gas exclusively, and he did not doubt that the same thing would apply to electricity suitably used. Electricity could be used very much more economically than it had been used in ordinary apparatus, and when it came down to something like ½d. or ⅜d. per unit it would be a very serious competitor to gas; it would be possible to do a great many things by electricity that were not possible now.

One other thing proved in his experiment had been that if the time of the housewife was of any commercial value at all, it was always cheaper to use gas or electricity than solid fuel. If a housewife's time was valued at 6d. an hour it was cheaper to use gas, and if it were valued at 1s. an hour the cost of the time so saved was greater than the whole cost of the fuel.

Mr. Llewelyn B. Atkinson, M.I.E.E., Past-President, Institution of Electrical Engineers and Member of Council, said he had amused himself with experiments of all kinds on house heating, and, like many others, he had been driven to regard the physiological side of the question almost more than the thermo-metric side.

The whole basis of the argument which had been put forward that evening was that, for comfort, a sedentary worker required a room at 64°. That meant raising the temperature, because the average temperature in the winter months in this country was not 64°. He believed, however, from his own experience with his own body, that the question of how we produced our own heat required looking into very deeply. There seemed a good deal of evidence to show that the only way heat was produced in the body was by the oxidation of sugars in the liver and muscles. If we were going to convert any other kind of food into heat or into muscular effort, we had to get it through a sugar process into the blood and oxidise it in the muscles. It seemed to him that if one was going to do heavy manual work, where what one wanted to do was to get the quickest conversion of food into heat or into muscular effort, one ought to feed on starches and sugars very largely. If, on the other hand, a person was going to occupy himself with sedentary operations he should use a form of food which, before it was converted into sugar was going to waste some energy in getting there, that was to say, produce some heat, and from that point of view he should eat more of the fats. In the last five years he personally had changed over from a diet which was largely starchy to a diet which was largely fat, and whereas previously he had had to work in a room of 65° he could now do sedentary operations quite comfortably all day long in a room at 52°. He had found that the change from starches to fats produced such an effect that one could do with a much lower temperature. Why the people of this country required such a high temperature in which to do sedentary occupations was because they did not eat enough fat and ate too much starch.

Professor Charles R. Darling, A.R.C.Sc.I., F.I.C., thought the average man in the street would always consider two things with regard to domestic heating—first, comfort, and secondly cost. A person might think a certain thing was very desirable yet the question of cost might put it out of his scope to use, and the question of cost of heating was one which must always tell, particularly with the masses of the people. From the point of view of comfort, a coal fire was the most satisfactory of any mode of heating. The great thing about the coal fire was the ventilating effect it had on the room. A room with a good coal fire in it seldom had that stuffy atmosphere to which the Chairman had so rightly objected. While hot water radiators made one feel warm enough, yet they gave an uncomfortable atmosphere, and gas fires appeared to send fumes into the room, which ought to go up the flue. In any case no appliance ventilated so well as a coal fire. That was why he believed in the coal fire for continuous heating. For casual heating the gas fire came out cheaper and was quite good.

What everyone was desirous of seeing was the success of the low temperature carbonisation experiments which were now being carried out. If by means of those experiments a fuel could be obtained which could be used in the ordinary fire grate instead of coal and which would be smokeless, then the present smoke nuisance would be got rid of, and all the comfort of a coal fire would be retained. He did not know whether it was going to be commercially possible. Unless the process could be made commercially sound he was afraid that the people would have to go on making the best of matters. The drawback he found with the kind of solid fuel obtained from low temperature carbonisation was that it burned rather rapidly and was not easily controlled.

Mr. W. W. Nobbs, M.I.Mech.E., Past-President of the Institution of Heating and Ventilating Engineers, speaking as a practical engineer, endorsed the remarks

of the last speaker that the two essentials which a heating engineer had to meet were firstly, to make his client feel comfortable, and, secondly, to do so at a reasonable cost. The only word of criticism he had to make on the paper was that Dr. Fishenden, in making her comparisons, had taken the cost of electricity at 2d. per unit whereas if she had taken 1d. per unit (the figure was in any case arbitrary), the ratios between the three classes of fuel would more nearly represent actual present day conditions.

MR. JOHN ROGER PRESTON (Vice-President, Institution of Heating and Ventilating Engineers) said the problem connected with the domestic heating of ordinary houses was very different from the problem of heating large public buildings. Whatever sort of heat was necessary just to finish off the effect by giving a comfortable feeling to the body, a fairly moderate basis heat was required. If an ordinary house in this country in the winter had no general heat, it was very draughty and its temperature varied from freezing point up to many degrees above. He was very strongly of the opinion that the most comfortable house was that which was centrally heated so as to maintain a moderate temperature in extreme conditions—for instance, a temperature of 45° to 50°. It then became a comparatively inexpensive matter to finish that heating by either gas or electrical heating. A room which was occupied could have an electrical heater which gave a nice comfortable radiant heat, and the consumption of electricity was very much lessened by having the ordinary temperature of the house at, say, 50°.

With regard to gas fires, it was difficult to see how a well-designed gas fire could make any difference to the air of a room, but it had to be admitted that it had some effect on most people. Possibly some people were more sensitive than others, but the fact remained that it was so.

Dr. Fishenden had remarked on the low thermal value of the electrical generator. Recently a good deal had been heard in the daily papers about the new electricity scheme. One gentleman of considerable repute, dealing with the question of having the generating stations at the pit heads, had said that surely it was more important to have them near plenty of water for condensing purposes. It seemed to him personally that that was a very retrograde step. He did not think that in this country sufficient consideration had been given to the utilisation of exhaust steam. The utilisation of exhaust steam was confined to a great extent to private concerns, and everyone knew in the case of private concerns what a very high efficiency could be obtained from a comparatively small electrical generating plant if that steam could be used. The great difficulty was to find uses for the steam, but in the new electricity scheme it surely did not seem impossible, taking the matter in its broad sense, to keep that point more in view than it had been. Instead of requiring plenty of running water to condense, we wanted industry to utilise the steam, because whenever steam could be utilised the efficiency of the engine became a somewhat secondary consideration. Admittedly, if that steam could not be utilised, the engine had to be of the very highest efficiency.

MISS EUPHEMIA SMITH said she had lived in houses all over the world—houses heated by gas, by steam, by electricity and by other means, but the one she had found most comfortable had been that which had been heated by solar rays. Although in that particular instance there had been only two or three hours of sunshine a day, it had been sufficient not only to heat the house but to give an abundant supply of hot water, and everybody had been healthy, strong and well. She wondered if such a system had been thought of for this country.

Mr. A. Honeysett said he would like to make a few remarks from the point of view of the man in the street. He had made a certain number of experiments, and he had always had the mortification of coming back to the distasteful fact that the old-fashioned coal fire had in the end proved the victor from the point of view of comfort and cost. Leaving aside all questions of desirable temperatures and radiations from the body and so on, the question was to determine how could one be healthy and comfortable at a minimum cost? He had fitted up a small room with a gas fire and had carefully calculated the cost of heating it, and he had found it had come to eighteen pence a day. The heat had been none too great and the atmosphere had been exceedingly disagreeable. He had then fitted up a considerably larger room with an old-fashioned register coal grate, and it had cost 9d. a day. He had fitted up another room of the same size with an anthracite stove. That had been very good; the heat had been very nice, it had lasted 24 hours, and it had cost 4½d. a day. In connection with another experiment in which he had used electricity, the cost had been 7d. a day. Another room, almost identical in size with the last, was fitted with a modern grate. This consumed 16 lbs. of coal per day, costing about 4½d. In comparing these last two it must be borne in mind that the electrically-heated room was an office occupied for only 6 or 7 hours per day, while the coal-heated one not only had a fire going for 14 hours a day, but also by means of a hot-water boiler, kept the room warm all night as well. The cost per hour of effective heating was, therefore, 1d. for electricity and 0.198d. for coal.

Dr. Fishenden, in reply, said that in regard to the physiological aspect of human heat requirements, she did not find herself in such disagreement with Mr. Barker as that gentleman appeared to think himself in with her. As the Chairman had stated, sensations of comfort were related to the condition of the skin; that was to say, it was specifically the difference in temperature between the surface and the deeper blood-vessels which controlled sensations of warmth or cold. Hence, as Mr. Baker had noticed, such impressions could be created very rapidly, for example, by radiation impinging upon the skin. She had purposely refrained from considering the question of cooking requirements on this occasion, having already tackled more than it was possible to deal with adequately in the time at her disposal. But she looked forward with interest to the publication of the report to which Mr. Barker had referred.

The Chairman had remarked that the heat production of children in open air sanatoria was sometimes increased to double the normal value. Probably it would be in the interests of health for people to accustom themselves to cooler rooms, that was to say, to encourage their chemical regulating apparatus to act more vigorously rather than to subject themselves to hothouse conditions. The problem, however, had to be attacked from the practical point of view, and the actual conditions demanded were not necessarily in accordance with hygienic considerations. She had purposely used the expression "the heat requirements of a civilised man," and civilised man had doubtless accustomed himself to an overwarm environment.

She believed that acclimatization might be, at least in part, an explanation of Mr. Llewelyn Atkinson's experience. She had not, however, intended to convey the impression that a room at 64°F. was the ideal environment for sedentary workers. There was little doubt that lower air temperatures in conjunction with radiation and adequate air flow were preferable, but the fact remained that where air heating alone was relied upon, sedentary workers in ordinary clothing were not as a rule warm enough unless the temperature of their surroundings approached 64°F.

She agreed with Mr. Darling that comfort and cheapness were the main demands of the ordinary householder. Most people were not in a position to seek ideal conditions, but were compelled by circumstances to consider comfort in relation to cost, and a compromise had to be effected. The popularity of the open coal fire for heating purposes was to be explained largely by the fact that it was at the same time comfortable and cheap. She could not conceive of modern gas fires properly fitted beneath a flue, sending into a room any appreciable amount of obnoxious fumes. What was the explanation of the complaints occasionally levelled against them she was not prepared to state. The matter had been touched upon in the paper, but much still remained to be learned about questions of heating, and the end of the problem was far from having been reached. Help could be given in regard to the smoke problem by further attention to the design of grates, and grate manufacturers should be urged to put on the market grates which were fitted for burning coke, whether of the low temperature variety or coke as produced from gasworks. High grade gas coke, low in ash and moisture, was a satisfactory substitute for coal for many household purposes.

Perhaps, as Mr. Nobbs had suggested, it was not altogether fair to take an average price for electricity, as it was most likely to be adopted for heating purposes where relatively low tariffs prevailed. But one had to decide upon some figure for the purpose of comparisons with other forms of energy, and 2d. had appeared to her a reasonable estimate. In any case, it was a simple matter to modify the comparisons given as desired.

With regard to Mr. Preston's remarks on the low efficiency of the generation of electricity, it had, of course, frequently been suggested that the exhaust steam should be utilized. But this, as he was aware, presented considerable difficulties except in special cases, owing to the problems involved in the successful transmission of heat in the form of steam over long distances. The position was relatively simple for works generating their own electricity, and here a higher overall efficiency was often attainable.

Owing to the difficulty of heat storage, the utilisation of solar radiation for heating purposes was not at present practicable in such a country as ours, where sunshine could not be depended upon. But experiments had been made in Italy and other sunny countries to examine its practical possibilities.

The last speaker had given some practical comparisons of great interest. If people in their own homes would make practical comparisons systematically carried out it would be of great help to investigators, because in the long run those were in a great many ways more applicable than experiments done in the laboratory. At the same time it was necessary to know the laboratory point of view—that was to say, what certain fuels would do under the best conditions or under standard conditions.

A hearty vote of thanks to Dr. Fishenden concluded the meeting.

NOTES ON BOOKS.

Modern History: 1750-1925. By H. W. Hodges, M.A., F.R.Hist.S. London: Blackie & Son, Ltd. 7s. 6d. net.

"For him history hung unsupported and unsupporting in the air. In the course of his school career he had several times approached the nineteenth century, but it seemed to him that for administrative reasons he was always being dragged

back again to the Middle Ages. Once his form had 'got' as far as the infancy of his own father, and concerning this period he had learnt that 'great dissatisfaction prevailed among the labouring classes, who were led to believe by mischievous demagogues,' etc. But the next term he was recoiling round Henry the Eighth, who 'was a skilful warrior and politician,' but 'unfortunate in his domestic relations'; and so to Elizabeth, than whom 'few sovereigns have been more belied, but her character comes out unscathed after the closest examination.'"

In these words Mr. Arnold Bennett describes the education in history of Edwin Clayhanger, and it may be taken as fairly typical of the average school up to, say, the end of the nineteenth century. In recent years, however, teachers have realised the desirability of making history more living, human and intelligible, and of joining up the past with the present. In former days this task was rendered difficult by the absence of suitable text-books. Most school histories stopped a good many years short of the present, and the average pupil, like young Clayhanger, never got within sight of his own times. Now, however, the problem has been rendered easier by the publication of several text-books. Excellent amongst these is the volume before us, which covers in an adequate manner the period from the middle of the eighteenth century to the present day. The author's method is to take one subject at a time, *e.g.*, the creation of the German Empire, or the making of Italy, instead of dealing in the same chapter with all the events in any one year, and thus we get a logical rather than a chronological sequence, which renders the story far more coherent and interesting.

The appendices contain useful summaries of the Treaty of Versailles, President Wilson's Fourteen Points, a diary of the Great War, and a bibliography for the use of those who desire to study any particular period in greater detail than it can be given within the limits of a general text-book.

Photo-Electricity: The Liberation of Electrons by Light, with Chapters on Fluorescence and Phosphorescence, Photo-Chemical Actions, and Photography. By H. Stanley Allen. Second Edition. London: Longmans Green and Co. 18*s*. net.

This work, which originated from a course of advanced lectures at King's College, appeared as a first edition in 1913, and in its present enlarged and elaborated form it may be regarded as a study of many somewhat obscure physical facts which cannot be connected exclusively with any one of the following sciences:—Kinetic Mechanics, Kinetic Chemistry, Electricity, Heat, Light. The lesson which the book appears to teach is that these five sciences are in reality but one; and this one manifests itself in five aspects, masks or appearances.

We are told by the author (p. 82) how he, in 1904, became specially interested in the aspects of physical work to which he has devoted so much attention and research.

The quantum theory of Planck as developed by Einstein seems to inspire much of the book. On p. 12 we find a conjecture as to how far new views on the transference of energy may lead to an acceptance of Newton's corpuscular theory of light and on the preceding page is to be found a consideration of Bragg's concept as to dropping a piece of wood into the sea from a height of 100 feet and so creating a wave or ripple which, after travelling 1,000 miles, may so act upon a wooden ship as to cause a similar piece of wood to fly from it to a height of 100 feet.

Whither the book will lead the thoughts and activities of a rather superficial reader may be a matter for conjecture; but the serious student will inevitably get new or extended views from every chapter.

AMERICAN HEMP.

(*Cannabis Sativa*).

GENERAL SUMMARY OF CONDITIONS IN 1925.

The shortage of Flax during the war, as well as the very considerable decrease in the growing of same, caused the Fabric Mills to use Hemp as a substitute with such good results that it is only by chemical analysis or microscopical examination that linen made therefrom can be distinguished from that made from Flax, thus opening up new avenues for the consumption of Hemp and renewed interest in growing, the methods employed and the costs of production.

Although the Hemp crop is one of the largest of the world's production of fibres, the greater part is still cleaned by hand, which is both costly and exceedingly laborious. It is self-evident that the great expense of installing Hemp cleaning mills, such as are now in use in the United States, has limited its production to areas within a hauling distance of the mills, and there can be no general growing of hemp until a method for mechanically cleaning it has been devised which is within the limits of the ordinary farmer, or of two or three combined ; plans of this nature are well under way with encouraging results.

Hemp grows in the temperate zones, requiring a good quality of land ; two crops are sometimes taken in succession off the same land ; the yield in fibre being about 1,000 lbs. per acre. The crop is planted in May and harvested in the latter part of August and September.

Hemp is planted in continuous rows by seeding machines, the rows being four to six inches apart, according to the richness of the soil.

When the "pollen" can be brushed off by hand, the crop is ready for harvesting, and is cut by a machine of special design, which cuts, lays out, and spreads the Hemp evenly in windrows.

The next stage is that of "retting," a process employed in the preparation of hemp, flax, jute and other bast fibres for machining or the hand separation of fibre from the wood. The fibres are first subjected to treatment by moisture—either of dew or rain or complete submergence. The fermenting bacteria arising therefrom consume the gum which causes the fibre to adhere to the wood, loosening it so that it can readily be separated.

The "retting" process takes from four to twelve weeks according to the weather. In wet weather hemp "rets" more rapidly than in dry. The amount of "retting" is determined by the readiness of the fibre to part from the stalk.

When the crop has passed through the stage of "retting" it is then tied in sheaves by machine, shocked for a time and later stacked until taken to the mill for cleaning.

This work, i.e., the preparation of the land, fertilizing (when required), seed planting, harvesting and delivery of the straw to the scutching mill costs $4\frac{1}{5}$ cents. per pound on the resulting fibre.

The crops vary in yield and quality. The best fibre is obtained from crops, the stalks of which are about the thickness of a lead pencil and from six to eight feet long. The large stalks which grow to a thickness of $\frac{3}{4}$" in diameter do not yield good fibre.

AVERAGE COST OF HEMP FIBRE PER ACRE FIGURED FROM LAND TO SCUTCH MILL.

Rental of land or interest on its value	$15.00	per acre.
Ploughing (one man with 3 horses plough $2\frac{1}{2}$ acres per day)	3.00	,,
Harrowing or pulverizing	1.00	,,
Seed	5.00	,,
Planting	1.00	,,
Cutting	5.00	,,
Gathering and shocking	5.50	,,

Stacking (2½ tons of straw)	2.50	,,
Average hauling to mill	2.50	,,
	$40.50	,,
Interest on outlay, $25 for one year	1.50	,,
	$42.00	,,

Yield per acre of fibre, 1,000 lbs.

Average cost of fibre $4.20 per 100 lbs.

Labour is figured at $2.75 per day, and horses at $2.00 per day.

The scutching, i.e., the reduction of the hemp straw to fibre is done from October to May, when farm labour can be most easily obtained. The mills are situated in farming districts as nearly as possible in the centre of hemp growing areas, to avoid long hauling of the straw, which is bulky and expensive to haul.

The mill usually consists of a drying room, 175 feet long, furnished with a movable platform throughout its length on which the hemp straw is laid and moved slowly through, the temperature being from 150-200 degrees Fahr. Hot air is circulated through the room by a large fan, which takes approximately 60 h.p. to operate. The speed of the moving platform is adjustable, so that the travel of the hemp straw through the drying room can be regulated to give more or less drying as desired.

After the hemp straw has passed through the drying room, it is fed through 10 pairs of gear toothed rollers and carried continuously in one operation by conveyors to beating or scutching drums, usually 3 pairs in a battery. These drums are about 7ft. in diameter and 6ft. wide.

The hemp straw is conveyed between these rapidly revolving drums by 3 endless chains, the hemp being spread on the chains by an operator. On the chains are spring pressed wires, which grip the hemp after it has been placed in equal lengths on each side of the chain by the operator.

The hemp in moving between the drums is automatically transferred from one chain to another, so that the part held by the first chain and which had no beating is transferred to the next chain and held in a different position and subjected to the beating action, the entire length of hemp by this operation coming in contact with the beating drums.

When the hemp emerges from the last pair of drums, it is gathered in handfuls of about 4 lbs. each, given a twist and tie at one end by an operator in order to keep each handful separate and from becoming entangled.

The hemp which is gathered off the chain is called " line hemp " and amounts to about 49½% of the hemp fed into the machines. The remainder is thrown off by the drums in a tangled mass and is called " tow," which amounts to about 49½%. About 1% is gathered from among the " shards," i.e., the wooden part of the stalk beaten off the fibre during the operation of " beating or scutching," and from the machine and floor. This fibre is classed as " upholstery tow."

All the " tow " is passed through another machine for rebreaking and removing of the shards.

In the prevalent methods of decorticating hemp described above, the straw is subjected to the bruising and breaking action, in order to break up the woody portion of the straw which is ensheathed in a coating of fibre.

The woody portion, when broken up, is known as " shards." In order to separate the shards from the fibre in which they were incased, the mass is submitted to the beating and combing action of six rapidly revolving drums having wooden blades and wire combs.

The severity of these processes is shown in the fact that barely one-half comes out in line (straight fibre is known as "line"), the remainder being shorter fibres, criss-crossed and tangled, and known to the trade as "tow."

As it is essential in spinning that the fibres should be parallel to each other, the loss to the spinner in straightening "tow" is 25 per cent. greater than in "line," therefore its lesser market value.

By a new method, recently tested by practical working, the fibre is first peeled from the stalks in ribbons and the projecting woody portion then broken into shards. As the fibre is never subjected to breaking or beating, no tow is made—the sole products of this method are line fibre and shards.

Assuming the capacity of both plants to be the same and the labour the same (although it is less by the new method), and the season's output 400,000 lbs.:

By the old method:

Cost of equipment, including 200 h.p. boiler and 150 h.p. engine capacity		$75,000.00
Season's expenditures:		
Interest on investment, 6 per cent.	$4,500.00	
Depreciation, 10 per cent...	7,500.00	
Insurance	2,000.00	
Labour	2,625.00	
	———	$16,625.00

Seventeen hands are employed 100 working days to produce 400,000 lbs. of fibre. These hands are usually farm hands employed by the year and get $50.00 per month and keep, say, $75.00 per month for 3½ months, the cost for labour being 65½ cents per 100 lbs.

RESULTS OBTAINED:

198,000 lbs. line fibre at present 18 cents per lb.
198,000 lbs. spinning tow at present 13 cents. per lb.
14,000 lbs. upholstery tow at present 7½ cents per lb.
1,000 tons of shards used as fuel for heat and power.

By the new method:

Cost of equipment		$15,000.00
Season's Expenditures:		
Interest, 6 per cent.	$900.00	
Deterioration	1,500.00	
Insurance	750.00	
Labour	2,625.00	
	———	$5,775.00

Results obtained:

400,000 lbs. of line fibre at present 18 cents. per lb.
1,000 tons of shards, at present $20 per ton.
(Shards make good bedding for cattle and very exceptional fertilizer for hemp crops.)

Difference in cost of operation on season's work ..	$10,850.00
Cost of growing and cleaning hemp by prevalent methods	$8.26 per 100 lbs.
Cost of growing and cleaning hemp by new method ..	$5.65 per 100 lbs.

NOTE.—The market value of hemp and the relative values of line and tow are continually changing.

G. A. LOWRY

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 p.m. :—

APRIL 14.—R. A. DAWSON, A.R.C.A., Principal, Municipal School of Art, Manchester, " Art Training for Industry and the Society's Competitions." SIR FRANK WARNER, K.B.E., in the Chair.

APRIL 21.—LIEUT.-GENERAL SIR GEORGE MACMUNN, K.C.B., K.C.S.I., D.S.O., " Some Aspects of the Business Side of an Army." THE RIGHT HON. VISCOUNT CHELMSFORD, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., in the Chair.

APRIL 28.—JAMES PATERSON, M.C. (of Messrs. Carter, Paterson and Co., Ltd.), " Horse Traction and Motor Traction." SIR HENRY P. MAYBURY, K.C.M.G., C.B., M.Inst.C.E., Director-General of Roads, Ministry of Transport, in the Chair.

MAY 5.—C. F. ELWELL, B.A., " Progress in the Radio Art : A Survey of Accomplishment and Possibilities of Future Development." PROFESSOR WILLIAM HENRY ECCLES, D.Sc., F.R.S., in the Chair.

MAY 12.—WARRE BRADLEY, " An Experiment in Industrial Welfare."

MAY 19.—RALPH J. PUGH, " British Film Production."

SPECIAL MEETING.

THURSDAY, MAY 6, at 4.30 p.m.—SIR FRANK BAINES, C.V.O., C.B.E., Director of Works, H.M. Office of Works, " The Preservation of Ancient Cottages." SIR CHARLES C. WAKEFIELD, Bt., C.B.E., in the Chair.

INDIAN SECTION.

MONDAY, MAY 31ST, at 4.30 p.m.—LIEUT.-COL. SIR ARNOLD TALBOT WILSON, K.C.I.E., C.M.G., C.S.I., D.S.O., of the Anglo-Persian Oil Company, Ltd., " The Military Record and Potentialities of the Persian Empire." The lecture will be illustrated by a Film showing the actual conditions of life among the military tribes of Persia. BRIGADIER-GENERAL SIR PERCY M. SYKES, K.C.I.E., C.B., C.M.G., in the Chair.

Dates to be hereafter announced :—

HERBERT BAKER, A.R.A., F.R.I.B.A., "The New Delhi."

CAPTAIN B. K. FEATHERSTONE, " Exploration in the Karakoram Mountains."

DOMINIONS AND COLONIES SECTION.

TUESDAY, MAY 4.—CHARLES PONSONBY, Managing Director, British Central Africa Company, " Nyasaland." BRIGADIER-GENERAL SIR S. H. WILSON, K.C.M.G., K.B.E., C.B., Permanent Under-Secretary of State for the Colonies, in the Chair.

Date to be hereafter announced :—

SENOR BOLIN, " Spanish North Africa." HIS EXCELLENCY THE MARQUES MERRY DEL VAL, Spanish Ambassador, in the Chair.

INDIAN AND DOMINIONS AND COLONIES SECTIONS (JOINT MEETING).

FRIDAY, APRIL 16th, at 4.30 o'clock.—LIEUTENANT-GENERAL SIR W. T. FURSE, K.C.B., D.S.O., Director, Imperial Institute, "The Work of the Imperial Institute." MR. A. M. SAMUEL, M.P., Parliamentary Secretary, Department of Overseas Trade, in the Chair.

CANTOR LECTURES.

CHARLES REED PEERS, C.B.E., M.A., Director, S.A., Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." Three Lectures April 19, 26, and May 3.

LECTURE I.—Definitions. The value and intention of ornament. Prehistoric ornament. Bronze Age. Hallstatt and La Téne. Classic and barbarian art. Lines of communication. Trade and invasion. The Roman conquests. Late-Celtic Art.

LECTURE II.—Roman Britain. The northern invaders. The Christian Mission. Iona and Northumbria. Benedict Biscop and Wilfrid. Offa of Mercia. Alcuin and Charlemagne. The classic revival. The Danes. The Norsemen. Alfred. Athewold and the School of Winchester.

LECTURE III.—Edward the Confessor, and the Normans. The Norman Conquest. English Romanesque. The evolution of Gothic art and its use of ornament. The high-water mark. The decline.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

TUESDAY, APRIL 6..Metals, Institute of, at the Chamber of Commerce, New Street, Birmingham. 7 p.m. Annual General Meeting.

WEDNESDAY, APRIL 7..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Master Glass-Painters, British Society of, at 6, Queen Square, W.C. 5.30 p.m. Mr. Aylmer Valence, "Stained Glass in Houses."

Public Analysts, Society of, at Burlington House, W. 8 p.m. Messrs. H. Droop Richmond and J. A. Eggleston, "The Analysis of Acetic Anhydride." Messrs. H. Droop Richmond and E. H. England, "The Analysis of Glacial Acetic Acid." Dr. J. F. Tocher, (1) "Errors of Personal Judgment in Chemical Work." (2) "Results of Further Work on Variations in the Composition of Milk." Messrs. E. Richards Bolton and K. A. Williams, "A Test for Tung Oil."

THURSDAY, APRIL 8..Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 6.30 p.m. The Marchese de Pinedo "A 35,000 miles Flight."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. S. Mavor, "The Applications of Machinery at the Coal Face." Mr. L. Miller, "The Design of Storage-Battery Locomotives for use in Coal Mines." Mr. R. Nelson, "Electricity in Mines: A Short Survey."

Mechanical Engineers, Institution of, at the Chamber of Commerce, Swansea. 6 p.m. Messrs. J. G. Pearce and J. E. Fletcher, "Foundry Papers."

Oil and Colour Chemists' Association, at 8, St. Martins Place, Trafalgar Square, W.C. Dr. A. P. Laurie, "The Optical Properties of Linseed Oil and the Technique of Van Eyck and his followers."

Structural Engineers, Institution of, at Denison House, 296, Vauxhall Bridge Road, S.W. 7.30 p.m. Mr. Ewart S. Andrews, "The Production of Structural Steel Sections."

FRIDAY, APRIL 9..Astronomical Society, Burlington House, W. 5 p.m.

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Mr. S. Hazzledine Warren, "The Preservation of Fragile Remains"; Mr. F. H. Worsfold, "An Examination of the contents of the Brick-Earths of Tankerton Bay, Kent."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. T. E. Dimbleby "Cast-iron Pipes—Modern Methods of Manufacture."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Annual Meeting.

Mechanical Engineers, at the Philosophical Hall, Leeds. 7.30 p.m. Informal Discussion on "What is Wrong with Industrial England?"

Metals, Institute of, at the University, St. George's Square, Sheffield. 7.30 p.m. Mr. R. T. Rolfe, "Bronze."

Philological Society, at University College, Gower Street, W.C. 8 p.m. English Dialect Society and Dictionary.

London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m.

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FRIDAY, APRIL 9th, 1926.

All communications for the Society should be add essed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, APRIL 14th, at 8 p.m. (Ordinary Meeting.) R. A. DAWSON, A.R.C.A., Principal, Municipal School of Art, Manchester, "Art Training for Industry and the Society's Competitions." SIR FRANK WARNER, K.B.E., will preside.

FRIDAY, APRIL 16th, at 4.30 p.m. (Joint Meeting of Indian and Dominions and Colonies Sections.) LIEUTENANT-GENERAL SIR WILLIAM T. FURSE, K.C.B., D.S.O., Director of the Imperial Institute, "The Work of the Imperial Institute." MR. ARTHUR MICHAEL SAMUEL, M.P., Parliamentary Secretary, Department of Overseas Trade, will preside. Tea will be served in the Library from 4 p.m.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, 2ND MARCH, 1926.

THE RIGHT HON. VISCOUNT BURNHAM, C.H., LL.D., D.Litt. in the Chair.

THE CHAIRMAN said it was a great pleasure to him to take the Chair that afternoon in this historical place for the purpose of hearing an address by Sir Basil Clarke on the question of "Publicity in relation to the Problems of Empire Trade and Settlement." No one was more capable than Sir Basil Clarke of saying a good deal about the subject in an interesting way. Perhaps it was true that we were all journalists now, more or less, but at the same time Sir Basil was a professional journalist of long experience and of high reputation. For some years he had worked on a paper which, although provincial in point of publication, was national

in point of importance—the "Manchester Guardian." He had also served on the staff of the *Daily Mail*. During the war and immediately after he was Director of Publicity in the Ministry of Reconstruction and the Ministry of Health, and subsequently went, in a very disturbed time, to Dublin, where he performed services of very great value to the State in the Irish Office. It was said of a well-educated man in times gone by that he ought to know something of everything and everything of something. Certainly that he should know something of everything was the demand made on the all-round journalist, but on the other hand, if he knew everything of something, so much the better. He believed that was true of the lecturer that afternoon, and had great confidence in calling upon him to deliver his address.

The following paper was then read :—

PUBLICITY IN RELATION TO THE PROBLEMS OF EMPIRE TRADE AND SETTLEMENT.

By Sir Basil Clarke,

Managing Director, Editorial Services, Ltd., late Director of Publicity, Ministry of Reconstruction, Ministry of Health and Irish Office.

It generally makes for clearness in a discussion of this kind to begin by defining one's terms, and I should very much like, if it were possible, to define and set finite limits to the problems of overseas trade and settlement. But Home Governments and Overseas Governments, big Englanders and little Englanders, economists, eugenists, sociologists and others all have their different views as to what these problems really are, and to accept the definition of any one group would tend only to create in you, or in some of you, a mental resistance which I do not want to incur quite so early in my remarks !

I shall not attempt, therefore, any comprehensive definition of these problems of overseas trade and settlement, but, keeping to common and non-contentious aspects of those problems, shall try to show to what extent—in some cases how very little and in others how much—publicity and propaganda might help towards their solution. Later, if you will allow me, I will touch upon some less obvious conclusions that I have come to about publicity and propaganda itself—a ground on which I am really more at home.

As to the problem of Empire trade alone, I take it we would all agree that it comprises (*inter alia*) the need for bringing about three results :—

(A) More efficient production—to create the best and, therefore, most competitive commodity at the most competitive price.

(B) Better salesmanship—to create and stimulate appetite for those products.

(C) Restoration and increase of purchasing power—to enable appetite to be satisfied.

Each of these three sub-sections is a vast problem in itself, and to go into all the steps necessary to solve them both at home and overseas would make

an economic volume. In this paper I shall limit myself to suggesting how skilful publicity might contribute something among the many contributions that are necessary to the complete solution of those three problems.

(A) To Bring About More Efficient Production.

It is often thought there is no room for publicity here, but I am convinced that there is a very large field for it in several directions :

(1) *Among Employers.* To get them out of old ruts—to get them to see, for example, that half-trained (and seemingly cheap) men are of less economic value than men of higher skill and payment ; that dissatisfied workers are, *ipso facto,* less productive workers ; that bad conditions of work are a tax on output and an added load on overhead charges ; that bad machines occupy as much house room as and use often more power than good. I know enough of factory administration in many parts of this country to be able to affirm that there is ample room for publicity and propaganda among the employing class of this country in these directions, and that such propaganda might contribute very substantially (and very cheaply) to the greater efficiency of British production.

(2) *Among the Workers.* To show, for example, that waste, whether of material or of time or of effort, is really their own loss in the long run, quite as much as their employers' loss and the nation's loss ; that by increasing the costs of production, waste is making for less employment, lower wages (or greater resistance on the part of the employers to higher wages): that it is decreasing the purchasing power, and, therefore, the real wages, of everyone, including themselves and the workers' class.

(3) *In the Office.* I might add that these comments, as regards employers and workers, are, in my opinion, equally applicable, if not more so, in the case of office administration, as well as in factory administration. Poor office equipment of machines and appliances, half competent typists and clerical workers (whose waste in time and material is appalling)—these are as much a load on the commercial efficiency of this country as the workshop evils I have mentioned.

As a pendant to my suggestion of propaganda among the workers, let me add that I do think a great deal of good would accrue from giving all workers a better and wider conspectus of the part that they and their work play in their firm's affairs (and in the nation's affairs) than they are able to obtain from the narrow viewpoint of their own bench or loom or machine or desk.

A big firm in the Midlands recently placed round their workrooms enlargements of the firm's foreign advertisements which were of a fine decorative and literary quality ; alongside were enlargements of an American firm's advertisements, equally attractive, of a similar class of goods in the same foreign market. The American firm strongly emphasised cost, which was

considerably lower than the British. I venture to think that the British worker, who is as 'cute as any other, would take in that little implication; that he would see what his firm was "up against" in selling in that market. Incidentally he would get also a much clearer and wider view of his own work than if these (to him) mysterious processes of competition and sales were left entirely unrevealed. Conversely, I think workpeople should also hear of successes achieved by their work. Such a course would be calculated to give a man a higher esteem of his job and of himself, and to arouse that "joy of the worker expressed in his work" which was the distinguishing characteristic of the work of the fine old craftsmen of this country. The worker who gets no joy out of his work, who gets no more out of his job than the money-wages he is paid for it is underpaid, however much money he earns. Man does not live by money-wages alone.

The field for industrial propaganda among employers and employed that I have named is a very wide one, and, to my thinking, a very fertile one. But it involves the most difficult and delicate type of propaganda work that can be imagined, and I trust that my remarks will not lead to amateur experiments —which might in this delicate arena be particularly disastrous.

(B) BETTER SALESMANSHIP.

The second of the trinity of problems which I enumerated as necessary to rehabilitate trade was the problem of better salesmanship. Here, probably, is the most immediately remunerative field for enlightened publicity and propaganda, and, at the same time, probably the most self-evident. Publicity, as one of the branches of salesmanship, has been so roundly championed by members of the advertising profession that it would be a work of supererogation on my part to cover the same ground, and I don't propose to do so. So long as the printed word will sell your goods at some fraction of the costs of salesmen, or serve as so cheap an ally to salesmen, there is no need for me to plead the case of the printed word.

"Selling" Propaganda.

Let me give just one illustration, however, of enlightened selling of an Empire product by advertising publicity coupled with propaganda. At the back end of last year, our very live friends, the Australians, had big stocks of currants and raisins which were not finding a market. An Empire Christmas Pudding movement was organised. In the Lord Mayor's procession last November 9th was an Empire Christmas pudding, big as a war balloon—a pudding of all British ingredients, especially Australian raisins and currants! The Empire Christmas pudding idea was propagated fully in the press, both in bought space and in editorial space freely given; the quality and the claims of Australian currants and raisins were amply emphasised. As a result, tons and tons of Australian dried fruit were sold this last Christmas, and, in addition, housewives of this country had a little timely and seasonable lesson

in "thinking Imperially," which may to some slight extent reflect itself permanently in their future household economy. I say "to some slight extent," because, unless this propaganda effort is followed up and made continuous over a wide field of Empire products, one lesson will be of little avail. An action must be repeated many times before it becomes a habit.

One more thought on this question of better salesmanship: To my mind, not nearly enough attention is given to the part that can be played by publicity in the creation of markets by the creation of tastes and habits. The habit of sending Christmas cards nearly ceased with the War. A campaign of publicity, editorial and advertising, by the Christmas card manufacturers revived it to full old-time vigour. You may have noticed a similar campaign only a few weeks back to revive the valentine-sending habit.

There must be many fields still open to traders for the creation of new habits. One Sunday, not long ago, I went down to the East India Docks with some of my sons to look at ships. From the deck of a big Australian liner we saw some twenty Asiatic seamen (from an Indian ship) amusing themselves on the dock side with a bicycle. One after another they were taking little rides in a circle of about 150 yards and getting as much fun and laughter out of it as out of some new toy. I wondered, in passing, whether any maker of British bicycles has given thought to the propaganda problem of extending the bicycle habit—and therefore his market—in countries where it is still evidently so much of a novelty.

The "Buy British Goods" Fallacy.

At this point, having reviewed some of the possibilities of trade stimulation by means of better production and keener salesmanship, I should like to interpolate a comment on the present-day advertising slogan "Buy British Goods." This exhortation, which we hear on every hand in Great Britain, seems to me to connote a wrong mentality towards the whole question of British trade revival—a sort of implication that it is the consumer's responsibility to revive British trade and that the producer and the merchant and retailer have no responsibility. I would argue that, on the contrary, the main responsibility is their's, not the consumer's; that the chief trade need of the nation at this time would be better expressed if the slogan "Buy British Goods" were altered to "Sell British Goods." In other words, I would sooner see the producers and the merchants and salesmen of this country galvanized into increased activity and keenness to make British products so good in price and quality and so keenly in demand (from the excellence of British salesmanship) that they made their way on their merits, and not through sentiment, into the markets of the world at home and abroad. Let our producers and merchants only achieve their part of this national duty and the consumer will not fail in his. He will buy British goods if the producer and merchant give him half a chance.

Of course, no propaganda will make new and additional trade over and above the purchasing power of the particular community or individual from whom trade is sought. It may divert his available money from one type of purchase to another, and possibly from a rival's produce to your own ; but in the nature of things it cannot get more out of a pint pot than a pint. This fact is commonly overlooked by enthusiastic advertisers of advertising who tend, in the old market-square fashion of salesmanship, to recommend their nostrum for all the economic ailments that trade is heir to. Publicity is powerless to create trade over and above purchasing power, and no advertising of Lancashire's cotton goods, for example, will sell those goods to more than an infinitesimal extent in communities whose sole reason for not buying them is lack of purchasing power—as is the case in many of the old foreign markets for Lancashire cotton goods.

This brings me to the third of the three sub-problems that I enumerated as factors of the greater problem.

(C) To Restore or Increase Purchasing Power.

I don't want to exaggerate the results that can be achieved in this direction by publicity and propaganda alone. But there is undoubtedly a substantial part that it can play as an ally to measures political and other. It can encourage, for example, the adoption of better methods and machines which make for better production. (All the better if we happen to make and sell those machines, as we do !) It can help to direct purchasing towards commodities of what I may call greater productivity rather than to commodities of little or no productivity. For example, it is clear that a saw is a more reproductive commodity than a bracelet ; that the hen-cote which the saw helps to make is likely to be more reproductive (purely from the point of view of purchasing power) than the added charm which some young woman gives to herself by means of the bracelet. Propaganda can be very potent in encouraging economy and saving. It can direct moneys towards productive quarters, such as banks and insurance companies, by whom it is employed in creating new productiveness or public works that make for greater productiveness. I think the banks and insurance companies could do much for the nation just now by a direct publicity assault on the individuals of this country to attract savings to their coffers, which would flow out again to encourage industrial and other productive effort.

Lastly, publicity and propaganda can contribute heavily to the creation, both at home and abroad, of an atmosphere of peace and goodwill, trust and understanding—the only atmosphere in which can be established financial credits and that confidence which leads to the starting of productive enterprises and from them to increased purchasing power.

Overseas Settlement and Industry.

You will have noticed, that so far, these comments of mine on three aspects of trade stimulation have been, applicable to all trade, whether Empire or foreign. They were advisedly made so, for what applies in principle to foreign trade applies equally well to Overseas or Empire trade. Though the Empire wants to be kind to us commercially, and *is* kind to us, as our export figures show, we have no right to expect favours or an undue tolerance of commercial shortcomings because our customers are friends and kinsmen. Our effort should be to give them the best possible deal for their money—just as though they were ordinary business customers. Our housewives and merchants and manufacturers will ask as much from them in the quality and marketing of the Empire goods that we are asked to buy.

But in Empire trade, as distinct from foreign trade, we have one great additional means towards economic adjustment and trade revival which does not exist in the case of foreign countries. That lever is Overseas Settlement. Here is a ready instrument for shifting back the weight that is depressing the steelyard of British commerce, and of so adjusting it as to bring that steelyard to horizontal and steady equipoise. Every consideration—ties of blood and kinship, considerations of our safety among nations, our whole future, both commercial and political as a race and people—urge us to adopt this great means of adjusting our economic equipoise.

With a population at home of nearly 500 persons to the square mile (482 to be exact) as compared with about two persons to the square mile in Australia and Canada ; with nearly 440 new and *additional* entrants to the home labour market competing for employment on every single day of the year, and over a million people out of work (notwithstanding the fact that industry has already absorbed more people than it did before the War) there is no need for me to stress to an audience such as this the benefits, commercial and other, which will accrue to the Empire, both overseas and at home, as a result of a well-considered policy of overseas settlement. I will assume a full agreement on that score and will deal only with the question as to how far publicity and propaganda can help.

It seems to me that our overseas settlement propaganda, like much other national propaganda that ought to be done, is left very much uncoordinated. As a result it is done piecemeal. It is mainly in the hands of separate organisations, either Dominion Government agencies or benevolent institutions or private land companies. The Government agencies and the private companies are special pleaders for their own particular dominions or territories ; the benevolent agencies help, for the most part, particular sections of the community. All give advice and other help to intending emigrants, and some few go further and seek to implant the desire for emigration. But not, I think, on the highest level. They appeal to the pocket, they appeal to the desire for gain and for comfort, the desire for change, and frequently they over-

gild the picture they paint. But I have yet to hear the case for emigration urged or presented on high national grounds, as an urgent national need, as a patriotic act. *The consequence is that the appeal gets no further than to the personally interested potential emigrant,* and then, as I say, only in terms of his comfort or his pocket. The man who is " down and out " is vitally interested, and wishes he could afford to go ; the man who is no great success in life in this country is interested, and possibly may scrape together the means to go ; the artizan and the farm-hand who are restless or financially ambitious—they may weigh up the pros and cons, again on a commercial basis, and they may go. But no one else is interested. There is no public opinion behind these men's choice. The Public and the Press do not bother whether they go or not. Emigration is to them, through faulty presentation, solely a remedy for unemployment, or a safety valve against congestion, or a means open to certain individuals of getting rich a little quicker ; and the British emigrant is allowed to sneak out of his own country, unwept, unhonoured and unsung. He goes on board a ship which, in public esteem, is held as being just about one grade higher in the social scale than a cattle ship.

I may say at this point that I have been an emigrant ; that I have worked with my hands overseas ; that I was excellently treated both on ship and on shore, and that I did very well. But that does not blind me to the low esteem in which emigration is held in this country.

Why is there so little public opinion behind overseas settlement, so little concern in it ; so little in the men who emigrate, in their going, in their fate ? A battalion of soldiers going abroad for a spell are made more public fuss of than a boat-load of emigrants leaving their homes for ever. A letter from a sailor doing his three years' service on the China station is better " copy " for his local paper than a letter from John Hodge, farm hand, who pulled up his roots and took his wife and children, say, to Canada for ever.

No, there is an inglorious aura round emigration (save in a few Scottish towns), and it is because of faulty presentation or lack of presentation, to the vast mass of the people of this country ; in other words, faulty propaganda. No Cabinet Minister that I remember has urged the patriotism of emigration ; the King's Speech has been silent on its need ; the leaders of affairs have not mentioned it ; naturally the Press are not going to beat a lonely and unprofitable drum of this kind ; and emigration, as a press subject, will continue to stagnate deep down among the lowly, non-newsy topics until someone takes propaganda steps to lift it.

Alter the Trend of New Labour.

That is, to my mind, the first publicity or propaganda problem confronting overseas settlement. With this problem solved—and it should not be a very difficult one—the great secondary problem of overseas settlement would become possible of solution : that secondary problem is vastly important.

It is: to give a new trend and direction to the never-ceasing flow of new labour which is continuously flowing into the home labour market. I mentioned earlier that there are 440 new people coming into our labour market every day—440 new people over and above those who retire from it; 440 new competitors *for jobs*, or more than 160,000 a year! And they are all of them, or nearly all, thinking of employment and careers in urban terms—not rural; in home terms, not Empire. The professions, the office, the workshop—these are the employments they visualise, and preferably the black-coated occupations rather than the workshop. You will never get overseas settlement brought about, or even our own rural population maintained, so long as this outlook and frame of mind remain as they are. You will have to begin correcting it far earlier and on arguments of much loftier appeal than are used in the overseas settlement propaganda of to-day. In addition, policy will have to precede propaganda to make rural life and occupation *really* more attractive, for, though Propaganda will do much, it is no good Propaganda attempting to do Policy's work. Unfortunately, so many of the sins of Policy are put down wrongly to Propaganda that it becomes half a propagandist's job trying to get Policy right. That is why, incidentally, I would plead for closer co-operation between Policy and Propaganda on all questions of public or mass concern. The psychological and dramatic values with which propaganda is so largely concerned become, in the case of any question involving mass mentality, well-nigh as important as the real values with which policy is concerned, and to frame policy without regard to propaganda values, as is so often done, is to court difficulty from the start.

Assuming this closer co-operation, how can propaganda be improved so as to make it more effectual?

Propaganda and News-Values.

The answer brings me to the last section of my paper, which I promised should contain some remarks on the means and nature of publicity and propaganda.

Publicity and propaganda aims at spreading particular knowledge or at creating a particular opinion, or at both. Most usually, its object is to create a particular opinion; and the spreading of knowledge is the means to that end. It is the best means. A man who comes to a conclusion by his own reasoning on facts presented to him is usually firmer in that opinion and more active upon it than a man who accepts an opinion ready-made. But the world is made up of both sorts of people; and many folk need, unfortunately, to have not only the facts, but the conclusion also, presented to them before their minds will arrive at that conclusion and accept it as their own.

Propaganda and publicity are concerned, therefore, with the dissemination of facts and conclusions—not necessarily together, but both facts and conclusions may be sown like two different sorts of seeds, careful selection being

made as to whether the one seed or the other, or both, can best be sown in a particular soil.

I will not discuss here all the different methods that exist of sowing these propaganda seeds—the spoken word, the printed word, the book, the lecture, the play, the song (for propaganda may be freely mixed with the arts), the pamphlet, the hoarding, the advertisement column, the editorial column, the leading article, the special article, the news article and all the rest. But, speaking of all forms of propaganda material, generically, I will say that, like the seed I have mentioned, it must have a germinating quality of its own, or it is still-born. That quality may best be described, perhaps, by the term "news-value." It is a journalistic term, but (*mutatis mutandis*) it is very applicable; and all propaganda matter can safely be judged in terms of its news-value. You can pay, of course, for the printing or other publication of anything you like, and a vast sum of money is expended every day in publicity the news-value of which—and therefore the efficacy—is virtually nil. It is all important, therefore, I think, that news-value should be understood by anyone with a propaganda problem before him, and as news finds its freest market (and, therefore, its keenest assessment) in newspaper offices, I propose to analyse news-value in terms of newspaper estimates.

News-value is the product of four principal factors—not the sum, but the product. The first factor is "importance," the second is "human interest," the third is "authority," the fourth is "time."

The term "importance" is fairly self-explanatory—does the news fact or opinion concern big issues or little, one person or many, does it concern them little or much?

The term "human interest" is nearly self-explanatory, but it is worth while remembering that human interest is more keen in persons than in things, in the particular rather than in the general, in the concrete rather than the abstract, in fact rather than in comment, in dynamic facts rather than static, in appeals to the mind through the eye or ear, rather than direct to the intelligence.

The third factor, "authority," is essential. Who is authority or sponsor for the statements made? Authority may be either stated or implied. In many items that appear in a newspaper no authority is mentioned. The paper itself assumes the authority. But it had an authority nevertheless. It may have been one of its own correspondents or reporters. If he got the statement from an official quarter or an important source, he prefers to say so if he can get permission to do so, for it adds news-value to his statement; the higher the authority, the higher the news-value. The catchlines, "from a correspondent," "from our correspondent," "from a special correspondent," have all a nicely-graded authoritative significance; and note with what avidity "authority" is quoted in headlines or in matter when any expression of opinion on contentious matter is given. To send matter of opinion to a news-

paper without giving it an "authority" is to invite an "assisted passage" to the waste-paper basket. "Authority" at its lowest warrants the acceptance of news as true; at its highest it enhances news-value.

The "time-factor" in news-value varies, of course, with different publicity media. A book or play may deal with events years or even centuries old; a magazine prefers to be reasonably topical; a weekly review must deal mainly with affairs of the week; but the daily paper, which is the greatest instrument of propaganda that we have, likes best the affairs of the day or even of to-morrow. Even a day's lateness is a tremendous handicap to any news item. Note how the morning paper struggles to get "yesterday" or "last night" into its news; the evening paper "to-day." The absence of a time-factor is a great handicap.

I have dealt with four main factors in news-value. It does not follow, of course, that no news-value can exist without all four of these factors. One or two factors in high degree may give a sufficiently high product of news-value to win acceptance. The news, for instance, of the method of the Tsar's murder made its way into gigantic headlines on human interest and importance alone, notwithstanding a weak "authority" factor and a very bad "time" factor, in that these details about his death did not emerge till many months after the fact of his assassination had been announced.

Though one or more good factors may create a fairly high news-value, the competition for newspaper space is so great that a propagandist cannot afford to neglect any of his factors; he must aim at creating the highest value he can get in each and every one, so as to enhance the product of them all.

Ninety-Nine per cent. for the "W.P.B."

Importance, Human Interest, Authority, Time! Judge by these tests the average paragraphs and articles received by newspapers "for favour of insertion" from big public undertakings who try to do their own propaganda, and even from Government departments! News-value factors are woefully ignored. One or more may be missing entirely and the others so low in value through unskilful treatment as to give the unhappy newspaper editor no justification at all for using the matter. Unfortunately, most of this matter is written by people who either have not known how to display the news-value of the raw material supplied to them, or who have been too lazy to take steps (such as inquiry, research, etc.) to reinforce it in those factors wherein it was weak. Often journalists who claim to be propagandists are guilty of this laxity. The reason is, of course, that most journalists are not called upon in their ordinary work to enhance news-values or to supply news factors that are missing. They are not propagandists. Most of them know nothing whatever about this work. But when they accept posts as publicists and propagandists, it does become their function to do so; their work is but half done if they do not.

That is the trouble with most propaganda matter to-day, and quite 99 per cent. of the propaganda copy (on innumerable subjects) sent to newspapers is doomed *ab initio* to the waste paper basket. That, similarly, is the trouble with most overseas settlement and emigration propaganda. For example, the greatest of all news-value factors has been under-treated—the factor that I called "importance." Emigration has been dealt with from the narrow viewpoint either of the individual careerist or of some individual Dominion; not in terms of national need, national importance, importance to each and all of us. That importance should, and could, be stated and shown in most striking fashion and in terms of livest human interest. The factor I called "authority" should be taken in hand. It has been gravely neglected. The highest possible authority should, and could, be found for facts and opinions and that authority named in the "copy." The time-factor should be more skilfully considered—and the best time-factor chosen for particular journals or media to whom the matter is to be offered.

And this news-building process should be repeated with different facts and arguments, with changed authority, with changed presentation and appropriate time-factors in each case.

The movement I have indicated towards altering the direction of the stream of new labour should also be taken in hand, first as a policy problem, and then as a propaganda problem, and attacked by similar methods. I do not think that Emigration and Empire-building would remain for long as one of the minor and unimportant news topics if it were handled in this comprehensive way by people who know something about news-value and how to create it.

A Matter for Inquiry.

I have tried to show what a field there is for propaganda and publicity n the solving of these two great problems of overseas trade and overseas settlement. I have also tried to show that propaganda is an expert business; that it is not an amateur's job. We are assured that the nation is shortly to spend a sum of £1,000,000 on the stimulation of overseas trade, through an Executive Commission, which, I take it, must include overseas settlement in its purview, and that the bulk of this million is to be spent in publicity and propaganda. Propaganda has suffered greatly in the past through being made an amateur's job. This was, perhaps, natural, because it was a craft which we, as a nation, had not developed. But that day is past. A good deal of real propaganda knowledge and technique has been accumulated in different fields, but not collated and correlated.

In closing this paper, I express the hope that the spending of that million pounds of public money, or whatever part is to be spent in publicity, will not be begun till some inquiry has been made into the various forms of propaganda available, their relative values and their several functions in a co-ordinated scheme, and, finally, into the highest standards of practice

in each branch. Such an inquiry would greatly amplify Government knowledge on an instrument of statesmanship which has a far wider application than to the immediate project in hand.

DISCUSSION.

THE CHAIRMAN said Sir Basil Clarke had covered a very wide field many parts of which offered opportunity for discussion.

LIEUT.-COL. SIR ARCHIBALD WEIGALL, K.C.M.G., said he was perfectly sure that everyone in the room must have listened with enormous interest to the informative lecture. With all the lecturer's ideals he felt perfectly sure they would all be in agreement, but he hoped Sir Basil would not mind if, in trying to visualise how those ideals were to be put into practice, he mentioned the snags which might be in the way. There was an immense field for propaganda of all sorts in connection with so enormous a question, and he agreed heartily with the lecturer when he said that that propaganda ought to be co-ordinated and collected into one useful channel. He felt that with the 36 voluntary societies that were endeavouring to deal with the whole settlement question, the effort would become far more effective if it were directed into a single conduit pipe as between the official circle and the voluntary circle. He was happy to think that before a week was out, owing to the efforts of Mr. Amery and the Royal Colonial Institute, all those Societies might have come under one umbrella and that would make it much easier for the lecturer's ideal of collective propaganda to be achieved.

The lecturer had asked why people did not go to the country and urge the people, not from any material motive, but from the highest ideal, to go overseas. That seemed the easiest thing in the world to "get over," taking as a text the marriage of the surplus population of the centre with the large open spaces and opportunities of the circumference—it was a magnificent text. But he was afraid that in practice, unless there was an equal propaganda effort simultaneously both at the receiving end and at the transmitting end, the whole thing might fall to the ground. The real difficulty, in his experience, was how very much more our people abroad knew of the aims, aspirations and ordinary public commercial life of this country than the people of this country knew of theirs. The difficulty was to get the propagandist who really knew the aims and aspirations and outlook of a young new country. That was really the big difference. It was true to say that 97 per cent. of Australians born in Australia were of our own flesh and blood, but that atmosphere of custom, convention or tradition, such as had become subconsciously part of the lives of people in this country, did not exist in Australia. He thought that a great dis-service might be done at this end by starting a campaign of propaganda to galvanise the whole country to make this great Empire of ours even greater than it was, unless before doing so we in this country had become a little more rural-minded and had developed a real land sense. Five hundred thousand boys and girls were leaving school every year, but how many of them had any real land sense? The vast proportion of them were lured much more by the pavement of the city than the fields of the country, and that was one of the great difficulties which had to be contended with, at any rate as far as Australia was concerned. Before any real galvanising could be done the whole mind of the country had to be turned much more to the field and away from the factory. It might be an arguable point whether in the long run it would be for the economic success of the country, but from the point of view of the particular question under discussion it was a practical difficulty

that the large majority of the youth of the country did not at present possess a land sense. He agreed that there was an enormous field for propaganda by intelligent and simultaneous control both at the centre and at the circumference, but before that could be put into really practical effect there was the very big work of educating public opinion as to what the general outlook of the country should be, distinguishing between the production of the urbanly-minded youth and the rurally-minded youth.

He thanked the lecturer most heartily for having galvanised him personally to a considerable extent.

Colonel the Hon. Sir James Allen, K.C.B., (High Commissioner for New Zealand) said he wished to express his regret that he was not present to listen to the earlier part of the paper but he had had an opportunity of reading the proof. He agreed very largely with what Sir Archibald Weigall had said, but he was not quite sure that he had completely grasped the movement which was now taking place in this country in respect to what was going on amongst those who were prepared to take up rural occupations in the Dominions. The Chairman was well acquainted with the fact that, so far as New Zealand was concerned, a large number of public school boys and others, who would have been depending on those who lost their lives in the war, were going to New Zealand in fairly large numbers with the distinct object of taking up rural life, being indentured to farmers, and New Zealand was looking to those boys to-day to carry out the policy which had been determined on many years ago. He had been very much struck with the ideal of propaganda set out by Sir Basil Clarke especially with regard to migration, and he hoped it might be possible by propaganda work to instil into the minds of those who wanted to go from this country the ideal of patriotism and not self-interest. The two had to be combined if it was possible. A man who was going to leave his home for Australia or New Zealand, had to consider himself and his wife and children, and he would not go unless he was assured that it was in his own interest as well as in the interest of the Empire. So far as he understood the lecturer the co-ordination he wanted with regard to publicity was a co-ordination of those who were engaged in propaganda in this country, in order that they might devise a scheme under which that portion of the million which might be made available for publicity could be spent in the best manner. If the suggestions of the Imperial Economic Committee were carried out there was no reason why that should not eventuate, because they had suggested that an executive committee should be set up with power to appoint sub-committees, and one of those sub-committees might be a publicity committee with the object of co-ordinating publicity work and devising the best means by which propaganda work could be made effective in this country.

With regard to trade, those who had come from the Dominions were extremely anxious that all the publicity and propaganda work possible should circulate in this country because the Dominions wanted to sell their products in Great Britain; but there again the essence of the whole thing was not so much propaganda as the production of the article itself and the way in which it was disposed of. It was no use attempting propaganda work in this country on any extensive scale unless the Dominions were able to give the consumers here good products and could assure them that they could obtain such products, wherever this was possible, all the year round, and also give them to the consumers at a price which would compare not unfavourably, at any rate, with the price at which they could be obtained from other sources. Propaganda work in this country would be valuable provided those conditions were fulfilled. There was need for propaganda work in the Dominions and

he was quite sure that the producers there would comply with the conditions he had alluded to. There were difficulties, but they were being overcome. For instance, New Zealand had solved the difficulty of the continuous supply of meat and was about to solve the problem of the continuous supply of dairy products. They could not, and perhaps never would, solve the difficulty of the supply of fresh fruit, but they could do a great deal towards it, and, in that sense, propaganda work was of use in New Zealand.

Lady Moore Guggisburg, C.B.E., said that Sir Archibald Weigall had laid great stress on the fact that when goods were sent to the Colonies it was necessary that they should be of the very best, and she thought great emphasis should be laid on that in any publicity campaign that was carried on. Nothing but the best should go to a Colony or a Dominion.

Lieut.-Col. A. Weston Jarvis, C.M.G., M.V.O., thought that after the able speeches from Sir Archibald Weigall and Sir James Allen it was very difficult to say anything which could throw any fresh light on the great problem, but he would certainly yield to no one in his desire to see the magnificent open spaces of the Dominions filled by men and women of the right sort from this country. It had been a great problem with many of those interested to know how best to set about solving it, and he was present that afternoon to listen to the author's ideas because he knew that there was nobody in this country who knew more about the right way to put the problem before the public than Sir Basil Clarke.

He agreed with Sir James Allen that it was very difficult to make a man who found himself crowded out in this country sufficiently patriotic to feel that he would go out to a country about which he knew nothing, unless he also felt he was going to improve his position. It was necessary not only to tell people what a magnificent country they were going to, but also to show them how much good they could do themselves by going there. The problems in the different countries varied very much, and that was again a difficulty in the way. There were many millions more people in this country than could be supported here, and the Empire could produce practically everything that we required. He knew more about South Africa than other countries, and South Africa differed absolutely from other countries because of the labour problem. The labour being native, it was no use a man thinking of going to South Africa unless he had a certain amount of capital to start with; in fact, the South African Government would not allow people to enter the country unless they had that capital. They did not want the country filled with men who had no means of subsistence or a job to go to, but for those with a limited capital there was a very fine outlook in South Africa, especially if they would cultivate what Sir Basil Clarke termed the rural outlook and not the black coat outlook. When the problem was put before young men and women of this country they were beginning to respond to it. What was wanted, particularly in connection with South Africa, was good propaganda and publicity, and he thought what the lecturer had said might give rise to considerable thought. The paper was deserving of very careful study and he thought everybody had received great benefit from being present that afternoon.

The Chairman said there was a splendid amplitude about the subject of the discussion which might keep the meeting profitably employed until midnight but every speaker ought to have his eye upon eternity and therefore he could not deal with more than a very small part of the subject in the few remarks he would

venture to make. The use of the word propaganda in connection with the subject was of very recent origin, going no further back than the Great War, when the word earned an unenviable notoriety. It was a word of perfectly respectable origin; it was an ecclesiastical term first used in connection with the Commission of Cardinals *de propaganda fide* established by Pope Gregory XV in 1622. The Commission was generally referred to as the Propaganda and the Secretary for the Propaganda was one of the high officials of the Holy See. Propaganda, he took it, meant nothing more than the popularising of knowledge. It might be applied, of course, to any knowledge, but in regard to trade and migration its object, he thought, was the increase and satisfaction of the felt wants of humanity. However, it was being spoken of mainly that afternoon in regard to the migration of British people and their redistribution over the British Empire according to its needs and its opportunities. Taking that as being the main purpose he ventured to express his agreement with the lecturer in his basic proposition that Overseas settlement had never been treated from a high enough standpoint; it had not been looked upon so much as an act of patriotism as an act of necessity. Was it, however, surprising that that was so? Some of its associations were not savoury. Undoubtedly the whole of the history of the Overseas Dominions and Colonies had been largely influenced in the last century and a quarter by the policy of penal transportation. It was not the case that those, who had first conceived the idea of peopling the New World with strains of British blood, looked at it from any low standpoint. Sir Walter Raleigh laid it down as the prime duty of the Sovereign to replenish the Realm when he was speaking of Imperial adventure. It was a great mistake to think that we conquered the world in a fit of absence of mind, as Seeley said, still less that we peopled it in the same manner.

Sir James Allen represented a Dominion that was deliberately settled with the best strains of British blood. The Church settlements of New Zealand were deliberately made and had turned out as excellently as could have been anticipated. The Church of England at Canterbury, the Presbyterian Church at Dunedin and in other parts of the Islands, builded even better than they knew. They must also remember the fine conception of Gibbon Wakefield who intended to apply the same principle of selected settlement to Australia, and did carry out a scheme which had led to such satisfactory results in South Australia, of which his friend Sir Archibald Weigall was Governor.

Therefore in spite of a good deal that was of ill-report, there was a good deal done to carry out overseas settlement in the right way, and there was every reason to rejoice over it. There was very little knowledge then and no publicity as it was known now in connection with any of the schemes. People went out in dense ignorance of what was before them and when they got there they were faced with dangers and difficulties of which they had no conception. Much to the credit of the British race they were nearly always equal to the emergencies in which they found themselves. He could not tell them, as Sir James Allen could, the history of New Zealand after they had got rid of the disreputable traders of the first days.

Colonel Weston Jarvis had spoken of a continent in which the 1820 settlers were great defenders of the Flag against hordes of barbarians in the Marches of the Eastern Provinces of the Cape, although they were drawn mostly from the population of London—tinkers and tailors and candlestick makers—and had no military training whatever until they found themselves on the veldt under conditions of very great peril.

Now the question was: ought the ignorance of those days to be allowed to continue? His own belief was that the truth was always the best, that the prospects

were so good and the movement so inspiring that the truth should be told and nothing but the truth. He himself was not in favour of propaganda that was too highly coloured or that only presented the rosy side of the picture. He did not mean to say that that was the case to-day, but personally he should state exactly what was warranted by the facts of the case, and not let everybody imagine that Overseas, either in Canada or Australia, New Zealand, or South Africa, there were "cushy jobs" waiting for every man who could not make a living at home. He did not find fault with the insistence of the Dominions on a high standard of health and physical efficiency; all he pleaded for was that the conditions should be thoroughly well-known and the standards fixed. He thought the Dominions could help this country and help themselves if the test here was not only all-embracing but also absolutely regular and undeviating. There had been disappointments caused—he did not say in any one Dominion in particular—by the fact that those who thought they would be accepted as migrants, in spite, perhaps, of some small failings, found on the other side that they they were rejected or, at least, that they were not welcome.

He believed that, on the whole, things worked well. He had a letter the other day from a Senator in New Zealand who drew his attention to the fact that they had to maintain at the public charge a certain number of degenerate persons among people of British blood. He was glad to say that when he looked into it he found they were the descendants of people who were taken out indiscriminately in the seventies of the last century, when there was a great expansion of the New Zealand population, and that nothing of that sort was going on, or could go on, under the present system. He was not decrying the appeal to patriotism which the lecturer made with so much power. After all it was only voicing again what had been said by all those who could be truly called the founders of the Empire. It was no doubt the case that men and women of robust character and of physical efficiency could do not only better for themselves but far better for the Commonwealth as a whole by going outside this country than by remaining in it. He was not talking of exceptional cases.

The reason that this had not been said more freely was that there had been a conspiracy of silence—which was now happily being broken—with regard to the whole movement of migration. He had been elected a Member of Parliament 40 years ago, and for the 30 years he sat in the House of Commons it was looked upon as almost improper to mention emigration; it was objectionable to both sides. The Tariff Reformers of later days said there was plenty of work for everybody in this country if they would stay and if we would only put up the barrier of restriction against foreign imports. The representatives of Labour said emigration was a capitalist dodge for getting rid of those whom the employers wanted to get out of the way, and not have to pay. The result was that for years and years in the House of Commons he was never able to raise the question of colonization in any form on the Colonial Estimates, although he had been a member of the Emigrants Information Office since 1894. Happily those prejudices and pretences had now been thrown off and people were adapting themselves to the existing order of things with wisdom and goodwill, and the subject of migration was being discussed every day in the week in the newspapers, on the platform and in Parliament. More light was required on the subject. He saw it stated the other day that human intelligence had been lately found by advertising for it, and he hoped that the right ways of dealing with the subject under discussion on an adequate scale would come out of such free discussion as was going on, and, not least, by such addresses as the meeting had had the pleasure of hearing that afternoon. He had to thank his friend Sir Basil Clarke in the name of the meeting, and to assure him that his lecture had been highly appreciated.

Sir Basil Clarke briefly thanked the Chairman and the Meeting terminated.

THE LIBRARY.

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NOTES ON BOOKS.

A Primitive Arcadia: being the impressions of an artist in Papua. Illustrated. By Ellis Silas, F.R.G.S. London: T. Fisher Unwin, Ltd. 15*s*. net.

This book is an attractively written first-hand account of some aspects of native life in Papua, or, to speak more precisely, in the Torbriand islands a few miles to the east of the main island of Papua. The author, an artist, and the son of an artist, spent three years living and painting in the islands, the outcome of an invitation from a friend who happened to be Resident Magistrate there. Mr. Silas, who is a lover of nature and primitive things, abhorring the whirr and rattle of modern civilisation, paints a very living picture of the simple life practised by these children of the South Seas. They are on the whole attractive people—independent and honest, industrious (when working on individual lines) and nearly always polite—though occasional incidents such as the roasting of pigs alive (page 199) and their Borgia-like proclivity for removing their enemies by putting puri-puri, i.e., poison, in their food, are slightly disturbing.

The author does full justice to the refulgent sunsets, the sunlit sea and coral, and the dark shadows of the almost impenetrable forests which nature in her most luxuriant mood offers to travellers in these seas. Certain passages of the book—the remarks on page 125 as to the whites who "go native," on page 133 as to the deteriorating effects of the plantation system, involving long absence from home and from tribal influences, upon the character and physique of the natives, and on page 151 as to the results of mission education on the girls, in regard to which an old Torbriander remarked, "What is the use of teaching my children how to *count* yams if they don't know how to grow the yams which they are to count?" have a general interest, inasmuch as the problems, to which these observations apply, occur in other parts of the British Empire. The author's views as to the unsatisfactory results of a too "literary" education for children, who will have to

make their living by practical work with their hands, will be endorsed by many in this country. There are also a good many references in the book to manifestations of primitive magic, which will be of interest to students of these phemomena; e.g., the reference on page 168 to the rites performed by the "garden magician" which precede each stage in the cultivation of the yam gardens. A number of good stories, e.g., on page 41, of a crocodile which carried in its mouth two miles down a river a woman who escaped from this terrifying experience unhurt owing to the providential intervention of a white man who was shooting game and issued from the bush at the précise moment when the crocodile deposited his victim on the beach, and another of a fight between a crocodile and a python, would make the fortune of a travel film. We will take the liberty of quoting from the latter story. 'My friend asked who was the victor. "Snake 'e 'old 'im crocodile altogether too tight," was the answer. "Then the snake won?" suggested my friend. "No," was the answer, "'im altogether too much dead." "Then," said my friend, "you mean that the crocodile won?" "No, Taubada," said the boy, "crocodile 'im altogether too much dead."'

This well-written book should be read by all who are interested in the out-of-the-way places of the world and in the manners and customs of the primitive peoples who dwell there.

PHOTOSYNTHESIS: THE ASSIMILATION OF CARBON BY GREEN PLANTS. By Walter Stiles. London: Longman, Green and Co. 16s. net.

Here we have a thoroughly satisfactory study of present-day views regarding reactions and changes involved in the first stages of vegetable life, that is to say, the fixation of carbon from atmospheric carbon dioxide in the presence of water, and inspired or energised by radiations which are broadly grouped as light.

Our author with a master hand leads us through the more than Cretan maze to which Priestley's experiment of 1771 with green leaves in water is the entrance, but it would be vain to attempt to touch even on the principal parts of the story embodied in 211 pages of text and some 50 pages of bibliography. We may, however, call special attention to Fig. 1 on p. 15 and the accompanying text. Here green cells are shown as studied and figured by Noll (Cf. p. 236), that is to say, cells in near similitude with the eye, the plastic granules which contain the chlorophyll adjusting themselves according to the incidence or the power of the light.

The term "Photosynthesis" appears to have a strictly proper and consistent application in relation to the reconstituting operation in the so-called additive process of colour photography; coloured lights, previously analysed out or separated, being projected on the screen. Nevertheless, to apply the term photosynthesis to the process of additive colour photography as a whole would be at the least inconsistent because the method in its general or broad aspects embodies both analysis and synthesis as quite essential and interdependent factors.

Somewhat similar conditions seem to obtain in relation to the author's use of the term photosynthesis as a general or covering title for his book. In illustration let us go back to the historic or fundamental example of photosynthesis in the sense of combination determined by light; the union of hydrogen and chlorine in one form of chemical photometer devised by Bunsen and Roscoe. Writing half a century ago we find that Roscoe described (Roscoe, Lessons in Elementary Chemistry, 1875 Ed., p. 105) the reaction as between HH and ClCl so that decomposition or analysis of two substances must accompany this synthesis of hydrochloric acid. Even if one rejects the molecular view, the physical and metaphysical views remain:

that every operation of synthesis is bounded by two operations of analysis and *vice versâ*. Thus, if a + b = c, we must assume that a and b are drawn somewhat from contiguity with other bodies. So important is clear wording and clear thinking in chemical matters that we consider we are justified in making the above remarks, but we have not the remotest sentiment of detracting from the merits or sterling importance of the work under notice.

It may be worth mention, in passing, that the iatro-chemists of the latter middle ages termed chemistry *ars spagyrica* thereby recognising that a chemical operation is both analytic and synthetic.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, APRIL 12..Automobile Engineers, Institute of, at the Birmingham & Midland Institute, Birmingham. 7 p.m. Mr. G. Rushton, "L.G.O.C. Methods of Omnibus Repair."

Chadwick Public Lectures, at the Museum, Maidstone. 7 p.m. Prof. Dr. E. P. Cathcart, "Food, Health and Energy."

Civil Engineers of Ireland, Institution of, 35, Dawson Street, Dublin. 8 p.m.

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Captain P. P. Eckersley, "The Linking together of Wireless and Wire Communication Systems."

At the Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. C. Vernier, "Some Impressions of Chicago and U.S.A."

At Exeter. 6 p.m. Mr. R. B. Matthews, "Electro-Farming; or the Application of Electricity to Agriculture."

Engineers, Society of, at Burlington House, W. 5.30 p.m. Mr. H. B. Cresswell, "An Inquiry into the Ugliness of Engineering Structures."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Paper by Mr. H. F. Lambart, "The Ascent of Mount Logan," read by Dr. T. G. Longstaff.

Optical Convention, at the Imperial College of Science and Technology, South Kensington.

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Discussion of papers on the various statutes which comprise the New Law of Property.

Structural Engineers, Institution of, 2-8, Victoria Street, S.W. 6 p.m. Mr. Ewart S. Andrews, "Theory versus Practice."

Transport, Institute of, at Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. D. S. Burn, "Railway Organisation."

At the Town Hall, Leeds. 5.30 p.m. Sir John E. Eaglesome, "Roadless Traction."

TUESDAY, APRIL 13..Aeronautical Engineers, at 39, Victoria Street, S.W. 6.30 p.m. Mr. S. H. Evans, "The Performance of Modern Aircraft with Special Reference to the Variable Wing."

Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. J. Stuart, "The Zulus in Peace and War."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. J. N. Reeson, "The influence of Electric Welding in the Design and Fabrication of Plant and Structures."

Colonial Institute at Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m.

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. W. S. Burn, "Double Acting Oil Engines."

Optical Convention, at the Imperial College of Science and Technology, South Kensington.

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 5.30 p.m. Mr. C. M. Hunter, "The Oil Fields of the Maracaibo Basin."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Barcroft, "The Salivary Glands."

Zoological Society, Regents Park, N.W. 5.30 p.m. Meeting for Scientific Business.

WEDNESDAY, APRIL 14..Architects, Royal Institute of British, 9, Conduit Street, W. 5 p.m. Mr. F. Inigo Thomas, "Gardens."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. G. W. Tripp, "The Young Engineer: His Training and Prospects."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. E. H. Shaughnessy, "The Rugby Radio Station of the British Post Office."

Hygiene, Institute of, 28, Portland Place, W. 3.30 p.m. Mr. E. B. Turner, "The Value of Sport and Physical Exercises."

Optical Convention, at the Imperial College of Science and Technology, South Kensington, S.W.

Structural Engineers, Institution of, at Manchester, Annual Business Meeting.

THURSDAY, APRIL 15..Aeronautical Society, 7, Albemarle Street, W. 6.30 p.m. Captain G. T. R. Hill, "The Tailless Aeroplane."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, Burlington House, W. 8 p.m.

Child-Study Society, 90, Buckingham Palace Road, S.W. 6 p.m. Mr. J. Norman Glaister, "The Educational Value of the Order of Woodcraft Chivalry."

Linnean Society, Burlington House, W. 5 p.m.

Mining and Metallurgy, at Burlington House, W. 5.30 p.m.

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.

Optical Convention, at the Imperial College of Science and Technology, South Kensington, S.W.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. O. H. P. Prior, "French Rhythm and English Poets."

FRIDAY, APRIL 16..Engineering Inspection, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. J. Venn Stevens, "Petroleum and its Products."

Optical Convention, at the Imperial College of Science and Technology, South Kensington, S.W.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Dr. A. W. Hill, "The Quest for Economic Plants."

SATURDAY, APRIL 17..Optical Convention, at the Imperial College of Science and Technology, South Kensington, S.W.

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. W. T. Calman, "The Ship-worm."

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: SOME CANTOR : AND OTHER LECTURES.

Recently delivered before the Royal Society of Arts.

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The Inner Structure of Alloys. Three Lectures. By WALTER ROSENHAIN, D.Sc., F.R.S. (1925.) Price 2s.

Copies of the above lectures can be obtained from the Secretary Royal Society of Arts.

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FRIDAY, APRIL 16th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, APRIL 19TH, at 8 p.m. (Cantor Lecture.) CHARLES REED PEERS, C.B.E., M.A., Director, Society of Antiquaries, Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." (Lecture I.)

WEDNESDAY, APRIL 21ST, at 8 p.m. (Ordinary Meeting.) Lieut.-General SIR GEORGE MACMUNN, K.C.B., K.C.S.I., D.S.O., "Some Aspects of the Business Side of an Army." The RIGHT HON. VISCOUNT CHELMSFORD, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., will preside.

COMPETITION OF INDUSTRIAL DESIGNS, 1926.

By kind permission of the Executive Council of the Imperial Institute, this year's Competition will be held in the Upper East Gallery of the Imperial Institute, South Kensington. Full particulars of the Scholarships and Prizes offered in connexion with the Competition can be obtained from the Secretary of the Royal Society of Arts, Adelphi, London, W.C.2. Applications for forms of entry, labels, and instructions must be sent to the Secretary between the 1st and 15th of May. Designs entered for the Competition are to be forwarded to the Imperial Institute between the 21st and the 23rd of June, and after the judging, which takes place in July, the accepted designs will be exhibited there during the whole of August.

PROCEEDINGS OF THE SOCIETY.

TWELFTH ORDINARY MEETING.

WEDNESDAY, MARCH 3RD, 1926.

MR. LLEWELYN B. ATKINSON, Past President, Institution of Electrical Engineers, in the Chair.

THE CHAIRMAN, in introducing the Lecturer, said Capt. Dunsheath was very well qualified to deal with his subject, as he was head of the Research Department of the well-known cable manufacturing firm of W. T. Henley's Telegraph Works Co., Ltd. The different stages in the story of that firm constituted a great business romance. The first stage had occurred in the time of W. T. Henley himself—a very remarkable man, and one of the first constructors of Atlantic cables. The second stage had been represented by the firm's financial troubles, due to extraneous circumstances which had led to it getting into serious difficulties. The third stage had been when Sir George Sutton, a Vice-President of the Royal Society of Arts, had gone into the business and had gradually disentangled it from its financial and technical difficulties, eventually bringing it to its present position of being one of the most successful industrial concerns in this country. It was a great business romance, well worth the study of those who took an interest in such matters. Personally, he always liked to look at the cause of great results, and he thought one cause of the success of the firm of W. T. Henley's Telegraph Works Co. had been that the head of that great business, and the man who had extricated it from its difficulties, had never feared to associate with himself, as his principal officers, young men—men who some might think had not sufficiently proved themselves, but whom Sir George Sutton had been willing to allow to prove themselves. By doing so Sir George had succeeded in getting round him the advantage of young minds, and men who were ready to take up the most modern view, whether of business or of science, and Sir George, therefore, was able to carry on the work of that great Company always with a young point of view before him. Captain Dunsheath was one of those young men in whom Sir George had placed his trust to establish a new experiment and a new ideal in a great manufacturing company, namely, a Research Department, deliberately constructed and intended to take care of every scientific problem, difficulty, technical fault and complaint that could come before it, and, furthermore to look into the future and see what could be done to improve the technique of a great science and a great art. The audience had in Captain Dunsheath a man who was head of a Research Department of a great industrial firm which was, perhaps (though he did not want to belittle the Research Department of any other firm), one of the boldest attempts, made almost regardless of cost, to set up in a works a department intended to turn technique into truly scientific knowledge.

The following paper was then read :—

SCIENCE IN THE CABLE INDUSTRY.

By P. DUNSHEATH, O.B.E., M.A., B.Sc., M.I.E.E., Head of Research Laboratories, W. T. Henley's Telegraph Works Co., Ltd.

INTRODUCTORY.

A recent writer has advanced the interesting, though gloomy, thesis that the influence of science on mankind is evil. He states that far from being

an isolated phenomenon the late war is only an example of the disruptive results that we may constantly expect from the progress of science. Man has released a demon which may at any moment hurl him into the bottomless void and our only hope of salvation is to stop the advance of scientific research.

Without doubt science has contributed extensively to the world's means of destruction, and in this respect its progress is to be deplored, but I think it will be generally agreed that, on a balance, mankind is happier as a result of the application of science. It would be easy to adduce a long list of examples in support of this contention, but I trust that what I have to say this evening about science in the cable industry may in itself form a strong piece of evidence that science is making, not for destruction, but for the advancement of mankind.

The application of science to cable making is not entirely a modern innovation. It is well known, for instance, how Kelvin worked on the theory of electrical transmission in the submarine cable half a century ago. Lesser lights than he have also replaced empirical by scientific method to a considerable extent ; but generally speaking, the cable industry has flourished under the direction of practical men guided by masses of collected data rather than by generalised principles. Cable making has been an art rather than a science.

During the past ten to fifteen years, however, increased demands have been made by the user for cables embodying highly specialised features, the design and manufacture of which require not only the highest technical skill, but also a very complete knowledge of scientific principles. The result has been a growing interest in the scientific side culminating, since the war, in a very definite movement in favour of industrial research. Of all branches of the electrical industry that of cable manufacture probably offers to-day the widest and most promising field for scientific research. Fundamentally, the problems are mainly connected with conductors and insulators, each of which branches is crowded with interesting and important problems awaiting solution ; but, in addition, there are many turnings leading very far into untrodden parts of electrical and other sciences.

Co-operative and Individual Research.

There are two broad lines along which cable research in this country is being carried on to-day, Co-operative Research and Individual Research. In the first of these, Co-operative Cable Research under the Department of Industrial and Scientific Research is being organised by the Electrical Research Association and to a lesser extent by the British Non-Ferrous Metals Research Association. The former association is supported by most British Cablemakers and under its auspices very extensive investigations have been carried out at the National Physical Laboratory and elsewhere. As an example the Heating of Buried Cables has been very fully examined and the whole question of current carrying capacity of cables placed on a more

satisfactory footing. The second Research Association mentioned is doing very valuable work in connection with the copper conductor and the lead sheathing.

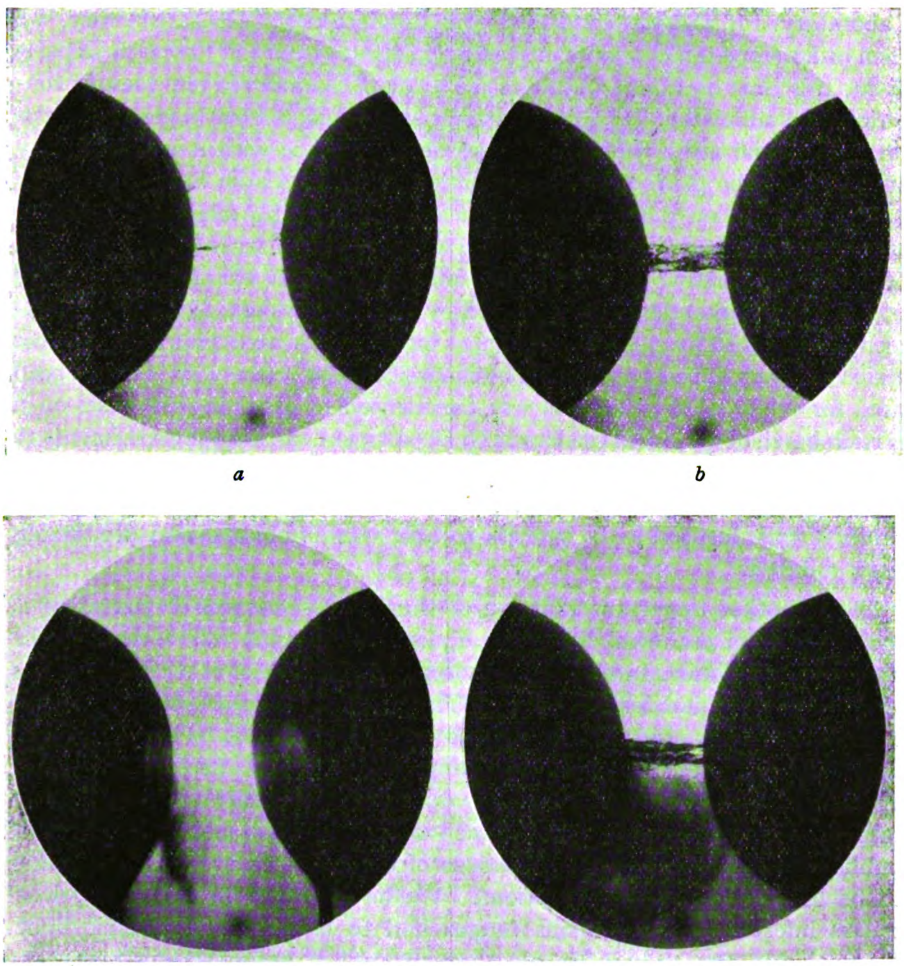
The Research Associations fulfil a very important function in carrying out investigations of common interest to cable makers and cable users and in effecting economies where pooling of information between makers is possible through such organisations as the Cable Makers Association. By co-operation with other bodies, such as the Institution of Electrical Engineers, British Engineering Standards Association, Government Departments, etc., very valuable work can be done in connection with the collection of data and the compiling of standards. These Associations have, however, a definitely limited field. To claim the fullest advantages of the application of science, the cable making firms must also carry out research individually and in close connection with the actual manufactures. Most of the British Cable makers are now doing this, some more than others. Certain of them have special organisations and staffs suitably housed and equipped for the purpose, others are still only groping towards the idea. I think I can claim that the Company which I represent has taken the lead in building and equipping the most up-to-date Cable Research Laboratory in this country, probably in the whole world, and later in the evening I will give you a few details of this organisation.

Functions of a Works Research Department.

In proceeding to a discussion of the functions of a Works Research Department and its place in the Company's organisation, my views will, of course, be influenced by the particular conditions under which I have been able to develop such a department. Generally speaking, however, I imagine that what would suit one cable manufacturer would not be far wrong with another, and as a broad principle, I would lay down at once that the primary object of the department is *not* to carry out fundamental research. There is quite sufficient known science to-day, and quite sufficient unexplained phenomena in a modern factory to keep a large organisation busy for a long time in just applying the knowledge that is available to explain the many anomalies met with in cable making. As an example of what I mean, the breakdown voltage of a power cable can be improved without any attempt to solve the riddle of dielectric absorption, although this phenomenon may be at the root of the matter. At the same time, any industrial research worker with a few years experience knows that it is impossible to go on employing known scientific principles very long without stumbling across new ones. The academic side without being sought is found, and if I ever heard of a university professor having difficulty in finding suitable fundamental problems for research, my advice to him would be to spend twelve months in a works laboratory trying to avoid them. In our laboratory we keep a proposals book in order to record the many new problems that arise in the day's work

to lure us from the one in hand. This book in itself is an absorbing study; and at the same time the despair of any man appreciating the shortness of human life.

The main object of the Research Department is to improve the product and, as quality of the finished cables depends both on the raw material and factory process, these items must take a large place in the research activities. Standards must be fixed for the acceptance of raw materials, a large amount of commonsense being used to avoid sending up the price by so doing, and a constant watch kept for alternative materials which are either better or



a b

c d

FIG. I.—Fibres in Oil.
(*a*) Fibres collecting. (*b*) Fibre chain formed. (*c*) Electrical breakdown.
(*d*) Combustion products clearing.

cheaper. Tests must be evolved based in many cases on a close study of the way in which the material fails. In testing the dielectric strength of insulating oils, for instance, we found that the presence of fibres in the oil had a most important effect on the result of the test. By projecting an image of the testing electrodes on to a screen we were able to study the action of these fibres. The electric stress between the electrodes causes them to line up across the gap as shown in Fig. 1, *a* and *b*, until ultimately breakdown takes place, as in Fig. 1, *c* and *d*. As an example of carrying research into the factory, it is the practice with us in examining a new proposal, say, for a special insulating compound, to try it out first on a one gallon sample in the Research Laboratory. If the results of these preliminary tests are satisfactory, we then order a one ton consignment and again try it out in the Research Department, this time on a larger scale in a Process Laboratory where factory conditions are simulated. Should the result still be good then larger quantities of the material are ordered and cables actually made with it in the factory on a part of the plant under the direction of the Research Staff. With the exercise of tact on the part of the research worker, this scheme works well, and ensures the rapid adoption of a new raw material with a minimum risk of disturbing routine production by failure. Another example of the way in which works practice may be altered by the activities of a Research Department is furnished by a case we had some time ago. A particular type of paper which was very expensive and had been considered to be the very best had been used for many years. Trouble was experienced in obtaining the tests on a certain batch of cable and the Research Department carried out experiments to determine the cause. The results proved conclusively that the paper far from being the best was one of the worst for the particular purpose, and as a result it was dropped; the process trouble was eliminated and production costs reduced.

Then another important function of the Works Research Department is the scrutiny of technical literature, indexing for quick reference, and the running of a technical intelligence service for the benefit of other departments of the Company and for customers. The user of cable nowadays has many other problems to study in addition to cables and cannot be a specialist on this subject alone. Generally speaking, therefore, in case of trouble or unusual propositions, he welcomes the assistance of the scientifically equipped cable maker and the rendering of such service to customers has a distinct publicity value. Frequent illustrations of this point occur where cables are to be laid under special conditions. We had a case, for instance, where cellars infested with a curious fungus had to be wired for electric light. By an elementary study in Mycology we were able to assure the customer that a certain type of cable would be perfectly immune from attack from the fungus which is shown in Fig. 2.

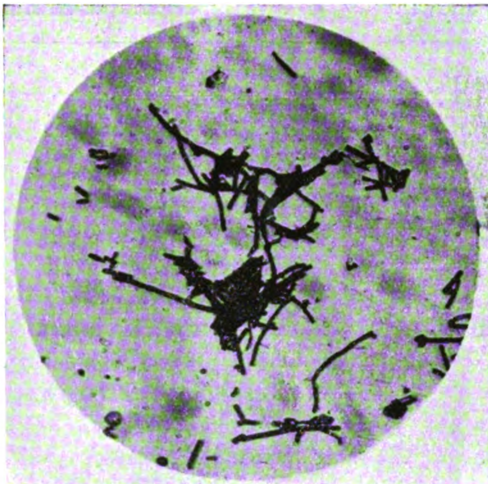


FIG. 2.—Rhacodium Cellare. x 210.

WIDE RANGE OF SCIENCES INVOLVED.

I mentioned earlier the wide field of science covered by the cable maker and it is of interest to examine this aspect a little more in detail. All the following separate sciences are employed to different extents.

Electricity.
Physics.
Chemistry.
Engineering.
Metallurgy.
Botany.
Entomology.
Mycology.

If we combine electricity and physics then probably it is the physicist who has the widest scope of application of all in cable sciences. He starts with the physical properties of raw materials such as, for instance, questions of insulating oil and serving compound viscosities ; there are few cable making processes, the success of which do not depend entirely upon the underlying physical principles ; and from the very nature of the requirements, it is the electrical properties of the finished cable which decide whether or not the materials used and processes followed have produced the ultimate result aimed at.

The many applications of chemistry are too obvious to need illustration. The examination of the following list of raw materials employed in cable manufacture will show that not only is analytical work of great importance, but that certain subdivisions of chemistry, as, for instance, the study of rubber, or of oils, could easily form in themselves whole time sciences :—

Material.	Tests.
Copper	Conductivity.
Lead Tin ... ... Antimony	Chemical Purity.
Steel Wire and Tapes ...	Physical Properties.
Paper	Micro-Structure. Impurities. Physical Properties.
Insulating Oils	Dielectric Resistance. Temperature Coefficient. Breakdown Strength. Chemical Purity.
Rubber	Chemical Purity.
Fillers for Rubber	Chemical Purity. Freedom from coarse particles.
Bitumen Pitches ... Tars	Physical Properties. Chemical Purity.
Gutta Percha	Resin Content.
Jute Cotton ... ... Silk	Physical Properties.
Waxes	Physical Properties. Chemical Purity.

The chemist who has not begun to run in a groove can do very valuable work in the maintaining of a high and rising standard of excellence in all types of electric cable and as a unit in a research team is second to none in importance.

The importance of mechanics, properties of materials and all that is covered by the broad title engineering, will be fully appreciated and a good example of this branch is illustrated by the hardness testing machine shown in Fig. 3. One of our works had a good deal of trouble owing to the annealed copper wire drawn in another works being too hard. Output was reduced by the fault, but owing to the absence of a measure of the hardness or durability which was not shown up by any known mechanical test it was difficult to trace the trouble to the source. The Research Department was asked to develop a test and the instrument shown is the outcome of the investigation. Instead of being dependent on the opinion of an experienced foreman who decided whether the wire was hard or soft by feel, we are now able to state the softness as a percentage figure which everybody understands and is able to check.

Another example of the development of a new test and the designing of a

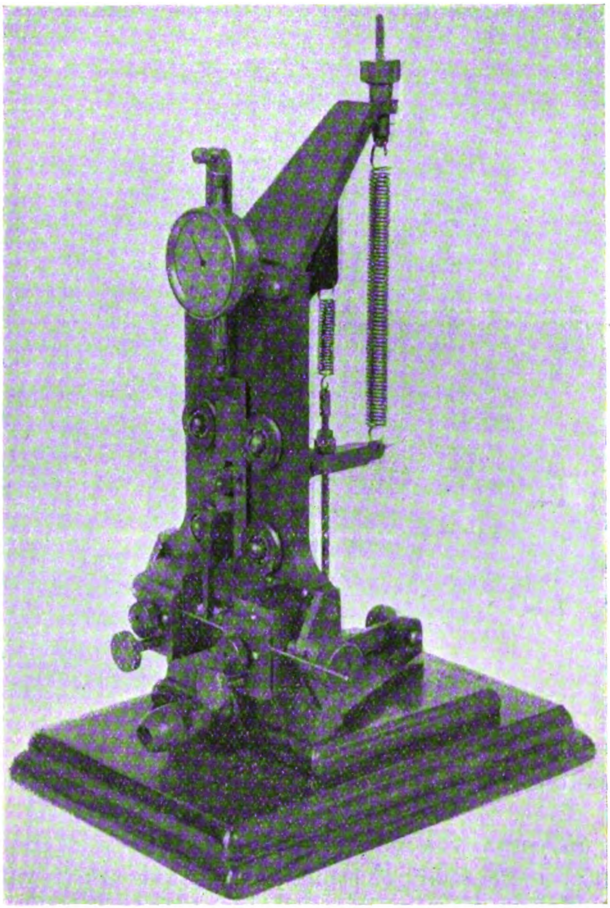


FIG. 3.—Copper Wire Hardness Tester.

special instrument to meet the demand is given by the Covering Power Tester, shown in Fig. 4. In order to compare the relative merits of different yarns used for lapping and braiding the extent to which a given weight will cover a given area is an important factor. No such test existed and the machine shown is the result of our study of the problem.

The necessity for developing new types of physical test is always cropping up and is one of the most outstanding features distinguishing industrial research from university research. For instance, we have to measure the viscosities of compounds many thousands times more viscous than the usual range of liquids previously examined and have consequently had to devise and make a new type of viscometer. The resistivity of extremely good insulating materials is so high that in the past it would have been recorded as infinity. We have made special apparatus with the extreme sensitivity

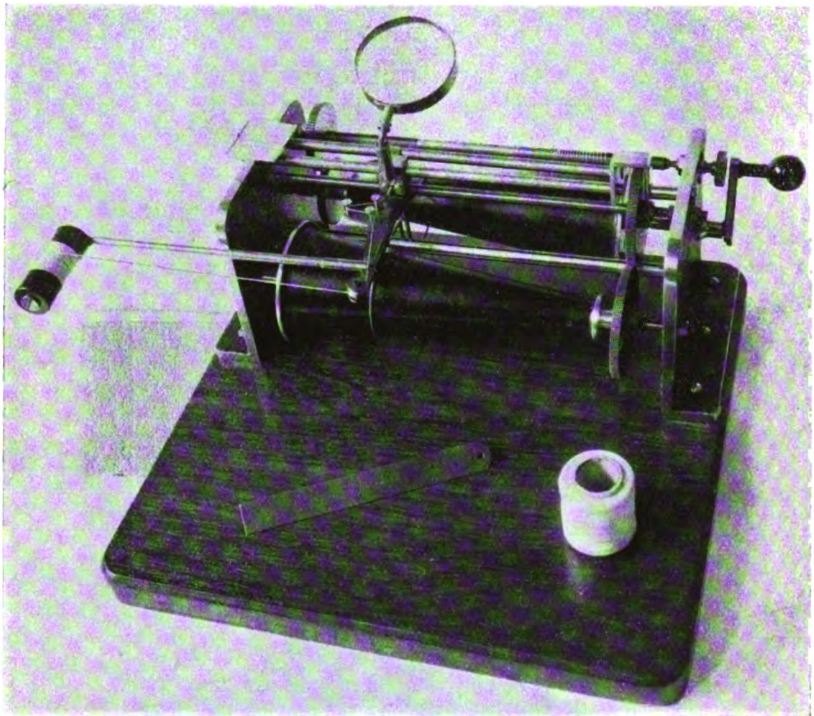


FIG. 4.—Yarn Covering Power Tester.

required so as to give a definite figure for the value which, of course, is not infinity.

Metallurgy, particularly in the microscopic examination of metal structures, as, for instance, in the study of lead sheath extrusion, is a valuable aid to quality raising and trouble finding. The criterion of efficient lead sheathing is largely a question of the perfection of the longitudinal weld. In the process of extrusion the lead flows around the cable as the latter passes through the press die and the two stream lines meet and weld together. The preparation of sections for microscopic examination by a technique which we have developed over the past few years enables us to throw considerable light on the nature of the extrusion process. Fig. 5 shows the crystalline appearance of a lead sheath after polishing and etching.

Disintegration of lead sheathing in service through mechanical vibration and stress is also a field of research in which the combined efforts of chemists and metallurgists are reaping valuable results.

As regards the remaining sciences shown in the list, although I do not wish to imply that every cable maker keeps a staff of botanists, entomologists and mycologists, these sciences are frequently of importance in dealing with specific problems that present themselves. Botany, for instance, enters into

FIG. 5.—Crystalline Structure of Lead Sheath. x 20.

the study of the various fibrous materials employed in large quantities such as paper, jute, and cotton. The microscopic examination of all paper used has now become a routine procedure in our laboratories, and certain connections established between the botanical features of the fibre and the electrical

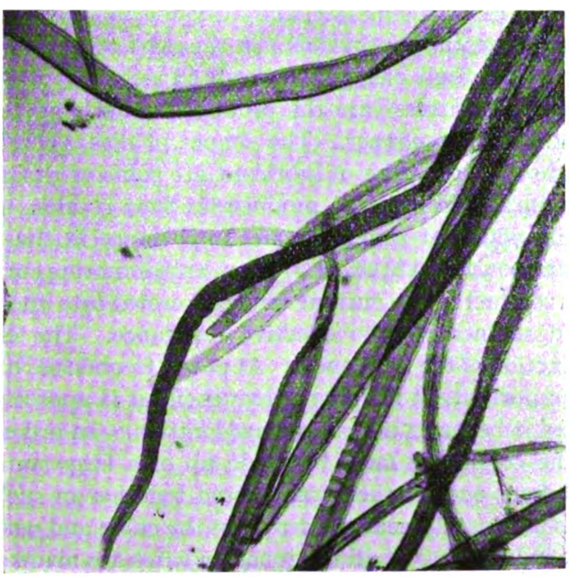


FIG. 6.—Fibres in Paper. x 150.

properties of the cable on which it is used. Fig. 6 shows the constituent fibres in a paper much used in cable making.

Examples of the application of entomology are the constant studies which we are making in the production of cables proof against the attacks of white ants and borer beetles for use in tropical climates. In this work we were fortunate in having the interest and co-operation of the late Professor Lefroy, whose untimely end a few months ago was so widely regretted.

I have previously mentioned an example of the application of mycology in the identification of a fungus. This science is also important in certain problems connected with the deterioration of cotton braiding and jute servings.

PROBLEMS IN THE CONDUCTOR.

The conductor of a cable does not at first sight appear to present any very complicated problems to the scientist. Certainly the problems are not so pressing as those in connection with the dielectric, but a moment's reflection will show that the science underlying the operation of electrical conduction in a metal is far from complete.

The standard of copper conductivity that has been in use for many years is perfectly arbitrary as has been demonstrated in an interesting manner during the past few months. The startling announcement has been made that a sample of copper has been produced with a conductivity of 113%.

In electrolytic copper we have a high grade uniform raw material. The total impurities in the commercial quality usually amount to less than six parts in ten thousand, four of which are oxygen. Analytical work on the conductor is thus a laborious matter, and although there is scope, no doubt, for enormous fundamental improvement in this part of a cable, the progress will only come as the result of highly specialised research.

Of more immediate interest are the problems underlying the drawing of the wire from the refined copper. The shapes of dies, speeds of drawing, temperature of bath and nature of lubricant are some of the factors to be correlated scientifically in order to produce the best results.

A phenomenon which at times assumes importance in the design of the conductor is that known as skin effect. When an alternating current traverses a solid circular conductor the current tends to crowd into the outer part of the section and so increase the effective resistance. The extent of this crowding is a function of the frequency. At power frequencies of 50 cycles per second it is unimportant, at telephone frequencies it is appreciable, while at radio frequencies it becomes a serious consideration. In order to overcome the difficulty the conductor must be made up of a large number of small wires insulated from one another and twisted together in such a way that each one travels alternately near the centre of the cable and near the surface. In this way the inductances of all the separate wires are made equal and the current shares itself equally between them. An interesting example of a

conductor made up in this way was recently manufactured by my company for the construction of large inductance coils to be used in the new Rugby Wireless Station. An end of the cable fanned out is shown in Fig. 7. The

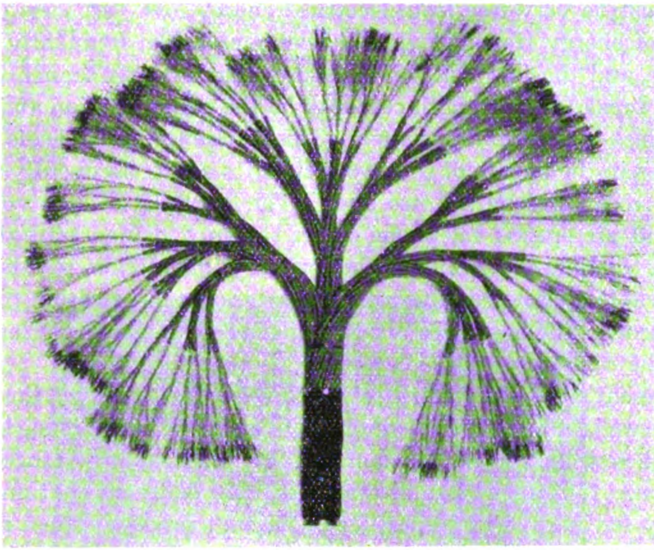


FIG. 7.—High Frequency Cable for Rugby Wireless Station.

cable which has a diameter of about 2″ consists of 6,561 copper wires each .0076 inch diameter. Each wire is insulated with a coating of enamel and three are twisted together. Three of these units are then twisted, then again three of these and so on until the total number is reached. The cable was made up into a coil, consisting of four spiders each wound with eight turns 8 feet in diameter, the spiders being spaced 12″ apart. The approximate length of cable was 1,250 feet and gave a total inductance of 2,500 U.H. In use the voltage across the core is 162,000 volts, and the measured resistance at 17,000 cycles 0.12 ohm. The measured D.C. resistance was .036 ohm, and it is estimated that if the coil had been made up of solid copper of the same sectional area the H.F. resistance instead of being 0.12 ohm would have been about 0.60 ohm.

Dielectric Science.

In turning to the dielectric of a cable we are faced with a problem of great complexity and one which is engaging the attention of many investigators in the industry to-day. As a subject for research the dielectric has interested scientists from the earliest days of electrical development, but never were the many unknowns so baffling and at the same time so important as now.

Primarily, of course, the function of a cable dielectric is to confine the current to the conductor and, in power work at any rate, the limitation is the

dielectric strength of the material. So long as it does not fail under the prolonged application of the high voltage employed for power transmission its purpose is fulfilled. On the other hand, in telephone cables the dielectric must not only be capable of withstanding the voltage without breakdown, but it must be very free from electrical energy loss. In view of the small amount of energy transmitted in a telephone cable, frequently less than a milliwatt, and the low voltage, it follows that for this branch of dielectric work the breakdown strength ceases to be the main criterion and the energy loss assumes first rate importance. This difference in use leads to essential differences in the nature of the two dielectrics and consequently to the technique of research along the two lines. The examples of high voltage power cables and air spaced telephone cables shown, † demonstrate this essential difference distinctly. Perhaps the primary distinction between the two types of cable dielectric is this: the more air contained within the telephone cable dielectric, the better the result, while in a power cable dielectric enclosed air may be disastrous.

The present state of dielectric science gives us no connected theory explaining all the well-known experimental phenomena, but we are being led more and more to the conclusion that the factor of fundamental importance is dielectric absorption. If voltage be applied to a cable the dielectric continues to absorb electricity for long periods and if the source of supply be then removed the stored up electricity can be drawn off for long periods as residual charge. Although the phenomenon has been known since the early days of submarine cables and many workers have produced masses of data and many different theories, we are still ignorant of its inner mechanism.

The electric stresses to which the dielectrics of all telephone cables and most power cables are subjected in use is alternating. When a perfect dielectric is charged in this manner, the charging current is ahead of, and in quadrature with, the charging voltage and there is no energy loss. Owing to absorption, however, the charging current in a practical cable dielectric lags by a small angle behind perfect quadrature and energy is dissipated. Each dielectric material under a given set of conditions has thus a characteristic power factor and the variation of this quantity with different dielectrics forms the basis of a very large proportion of the work of a cable research laboratory. To determine how to reduce the value without introducing other weaknesses is the object of every up-to-date cable maker.

In passing, it is of interest to note how the cable maker, covering as he does the science of dielectrics used in such widely different fields as power transmission, telephone transmission and wireless, is compelled to use three different methods of expressing the quantity power factor to suit the three types of experts. The low frequency engineer working in 50 cycles always

† The lecturer exhibited a number of samples of electric cables of various kinds.

talks of power factor, the telephone engineer uses the ratio $\frac{G}{C} \; \frac{\text{Conductance}}{\text{Capacitance}}$, while the radio expert thinks in terms of equivalent resistance.

The subject of the variation of dielectric loss and power factor with temperature frequency and voltage is in itself a very important part of the cable scientist's work. It is, however, much too extensive for adequate treatment in one section of a paper of this kind, and to summarise the matter briefly, I show a set of models which illustrate the most common features. The first four models illustrate the variation of power factor with voltage and temperature for four different impregnated paper cables made up with different materials. The low flat curves are the ones aimed at. Fig. 8 illustrates the set of models shown during the lecture.

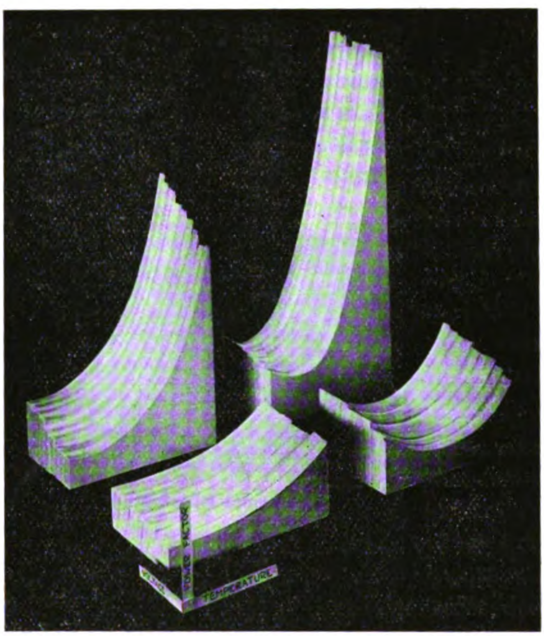


FIG. 8.—Solid Diagrams for illustrating Dielectric Properties.

The third and fourth pairs show the variation of both loss and power factor with frequency and temperature as based on power cable test results.

Leaving the question of dielectric loss, I shall only have time to indicate briefly the salient points in connection with dielectric strength. This characteristic may be defined as the voltage required to rupture the dielectric. Unfortunately, complications again enter, as the time during which the voltage is applied affects the value obtained resulting in the time-voltage relationship. At very high voltages the time of application affects the break-

down strength enormously, while at lower voltages the effect of time is less marked though apparently still present. The collection of cardboard curves shown indicate the nature of this time voltage relationship. Each of these curves represents the results obtained on one length of cable and requires six or eight sample pieces to be specially prepared and tested to destruction so that it will be seen the examination of the effect of different raw materials and variations in factory process is a costly business involving heavy expenditure in both time and material.

In order to obtain a clearer insight into the nature of cable breakdown with paper cables complete and detailed post mortem examinations are carried out on samples which have been treated in various ways and tested to very high voltages. The appearance of the separated papers is frequently a great help in diagnosing the case and an example of such a series of papers is shown on the long board. It will be seen that curious tree shaped markings appear at certain points. The incidence and nature of these markings when correctly interpreted is a valuable guide to improvement in design and materials. The larger samples in the glass slide have been produced artificially to show more clearly the nature of the deterioration. Fig. 9 shows a typical appearance of this type of electrical failure.

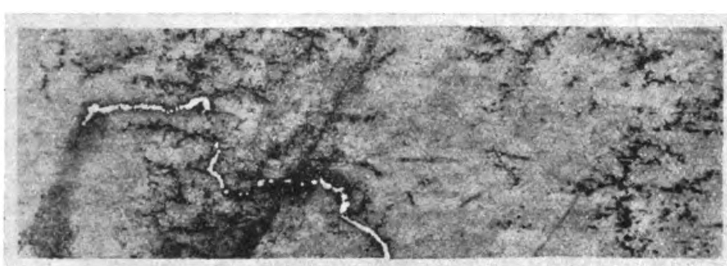


FIG. 9.—Study of Electrical Breakdown in Paper.

PROBLEMS SPECIAL TO TELEPHONE CABLES.

I should like now to give you an idea of the type of problem which is keeping us busy on the telephone cable. Fundamentally, we are anxious to produce a cable which will transmit speech with the minimum attenuation and minimum distortion. Not only is it necessary that the energy of the speech wave impressed on the sending end shall reach the receiving end without too much loss so that the hearer shall have volume of speech, but it is also important that what he hears shall approximate as nearly as possible to what the speaker says, and compliance with these two requirements makes the telephone side one of the most mathematical and complex of any of the problems that cable makers have to solve. It is quite impossible to give anything like a detailed exposition of our work in this direction in such a lecture as the present, but I might refer to the question of loading as a further illustration

of the difference between Research Work in industry and research work in a university.

A highly scientific improvement of the conductor used for certain types of telephone cable lies in continuous loading or the increase of inductance by the lapping of magnetic material round the copper wire or strand. The files of the Patent Office during the past few years provide evidence of considerable ingenuity having been displayed in the production of a high permeability and low loss coating and, in the United States particularly, very large sums must have been spent on research in this particular field. A sample of continuously loaded submarine telephone cable is on the table showing the magnetic loading.

Owing to the very tiny currents employed for telephone transmission the value of the magnetic field on which the loading material works is very small. In comparing different materials then we are called upon to measure permeability at values of H very much below that of the earth's field and at values consequently very much lower than those previously employed in university laboratories.

In order to avoid overhearing and cross talk between different circuits in a telephone cable special care has to be taken in manufacture so that the different electrical properties are balanced as nearly as possible. The measurement of capacity unbalance and cross talk between circuits involves the employment of special apparatus shown, and residual values are then balanced out on the road in jointing one length of cable to another. Very special requirements, as laid down by an international conference of telephone engineers, have to be met for long distance circuit balances and here again the highest scientific skill is called for in design and manufacture. The actual requirements of the Paris Conference are much too long and complicated to be quoted here, but as a very rough indication of the nature of the requirements, I may say that the allowed unbalances per mile of cable are measured in quite a few micro-micro-farads, and the maximum cross talk in millionths of the impressed speech.

Science of External Protection.

Up to the present we have dealt with the electrical part of the cable, but a considerable amount of science is required in dealing with the mechanical protection. For instance, in the lead sheath of a power cable currents are induced by those traversing the main conductors. The effect of these parasite currents is in any case to incur losses by heating. With single core cables these sheath effects are much more important than with multicore cables, and in certain cases as, for instance, when a single core cable is carried through an enclosing iron pipe, the effects may be positively dangerous. The determination of the laws governing these effects and the mathematical application to specific cases is very valuable work. It can, of course, only be carried out

with special staff and equipment, but is a good example of the value of a Works Research Laboratory in helping customers with unusual difficulties which one in a hundred could never be expected to solve unaided.

Much might be written on the cable enemies, corrosion and vermin, the way in which they affect the protective covering, and keep the chemists busy both in devising deterrents and in diagnosing trouble when it occurs. The question of selection of personnel and the psychological side of research is also of absorbing interest, but I must pass these by and show you in conclusion a few views illustrating the lay-out and equipment of the Henley Research Laboratories.

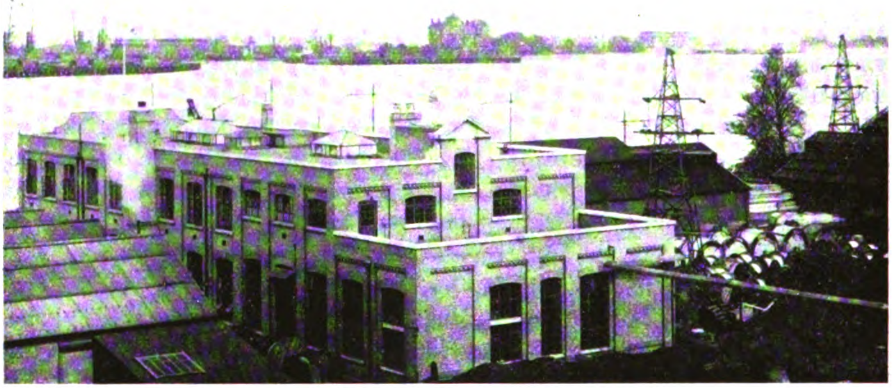


FIG. 10.—Henley Laboratories. General View.

HENLEY RESEARCH LABORATORIES.

The building which comprises the various Laboratories, experimental workshops and administrative offices, consists of two stories with a otal floor space of 14,000 square feet. Heavy transformers, generating plant, etc., together with apparatus susceptible to vibration, such as galvanometers and microphotographic equipment, are restricted as far as possible to the Ground floor, while the Chemical Laboratory, Library and Offices occupy the upper floor. The rooms are spacious and lofty, and in addition to the provision of good natural lighting through large casement windows, adequate artificial illumination is secured by means of direct general lighting from 200-watt units in prismatic reflectors.

Each floor is divided longitudinally by a corridor giving access to the rooms at both ends and on either side. The High Tension Laboratory, which occupies one end of the Ground floor, is equipped with new and complete modern testing plant for the measurement of dielectric losses, and for applying high

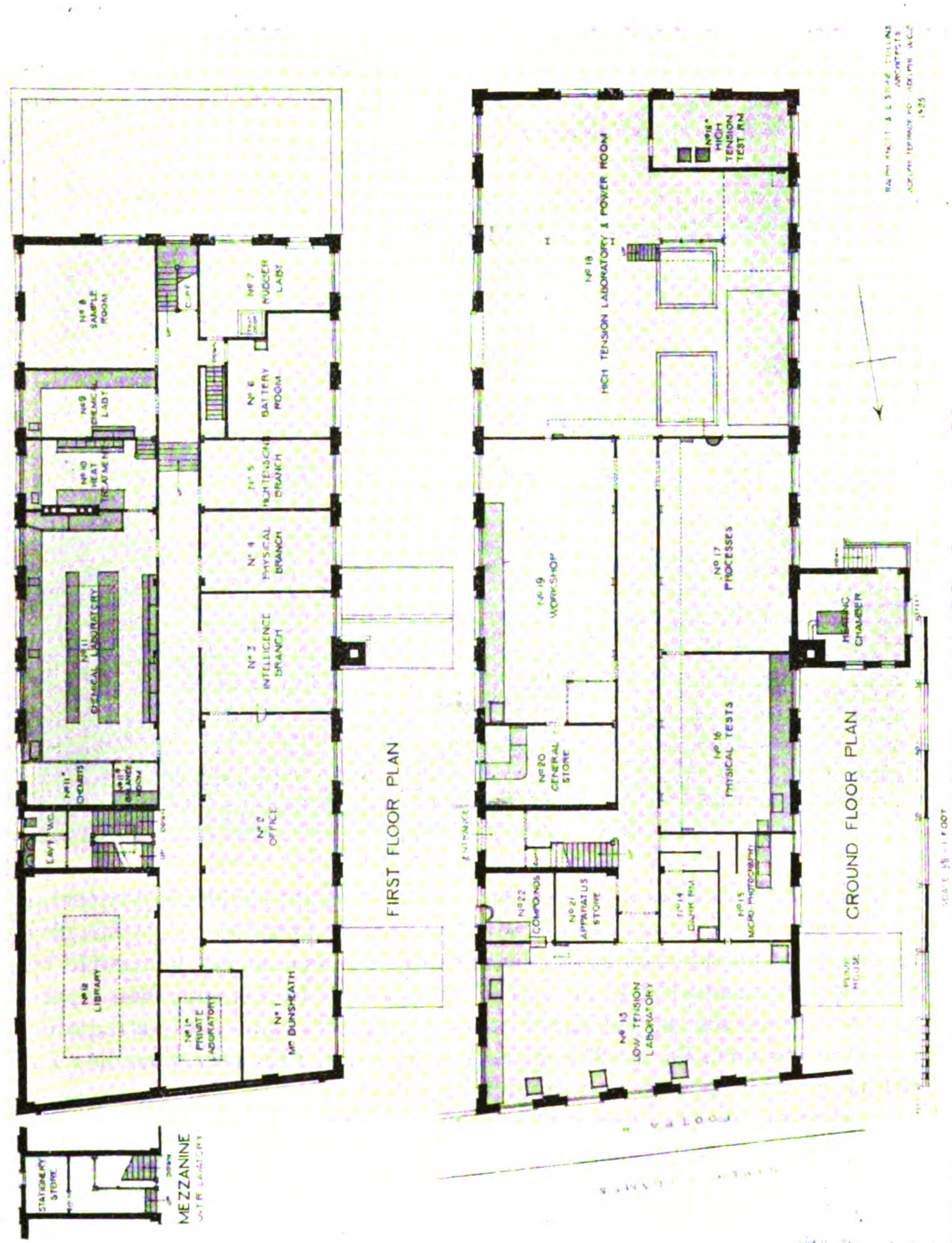


FIG. 11.—Henley Laboratories. Floor Plan.

voltage tests to finished lengths of cable at pressures up to 210,000 volts 3-phase and 375,000 volts single phase.

In the low tension laboratory at the opposite end of the building, apparatus is installed for the detailed examination of the physical and electrical properties of impregnating compounds.

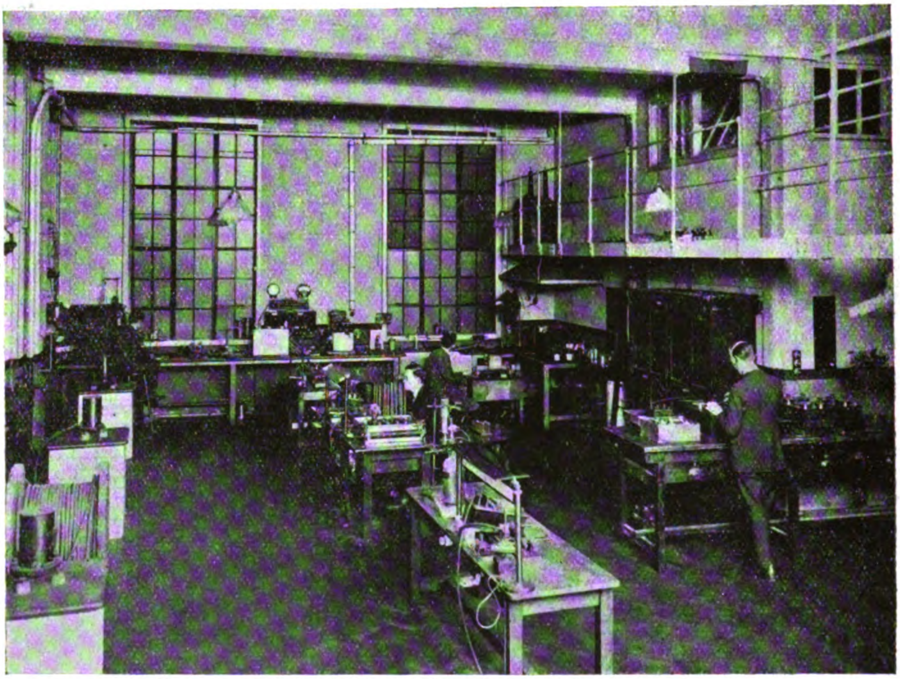


FIG. 12.—Henley Laboratories. Low Tension Laboratory.

In the process laboratory a model impregnating plant enables experimental lengths of cable to be made under strictly controlled conditions, so that new ideas may be tried out on much smaller batches of compound than would be necessary for an experiment on the full works scale. In this same room, space is also reserved for the development of other processes as may be required from time to time, the machinery being installed in a temporary manner for the actual investigation, and subsequently dismantled.

In view of the importance of microscopic examination of many of the materials used in the manufacture of electric cables and accessories, a complete and up-to-date microscopic and photographic equipment is installed, with which an expert Microscopist is kept constantly busy.

On the upper floor, the main and subsidiary chemical laboratories have many features of special interest, and the library contains a representative collection of the world's technical literature affecting cables. Figs. 10 to 14 are principal views of the laboratories, but as a full description of the equip-

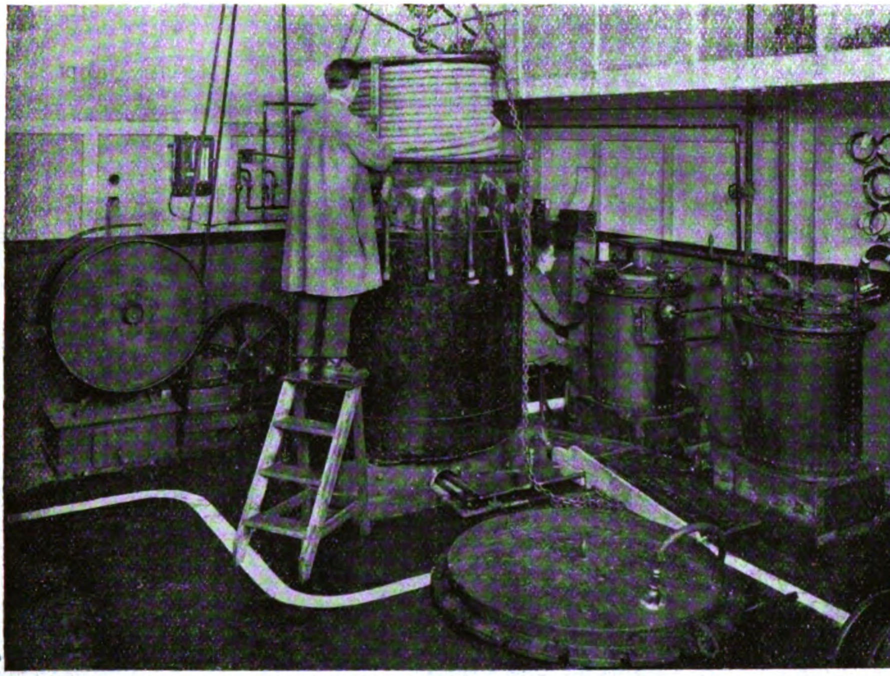


FIG. 13.—Henley Laboratories. Process Laboratory.

ment of these laboratories has already been published in the electrical press, I will refer you to this for details.

CONCLUSION.

In conclusion, I should like to quote some recent words of Mr. E. W. Rice, the American business magnate. He says:—

"If you have no problems in your business, if you are perfectly satisfied with your product, your processes and your costs in all respects; if you have no troubles from competition, or other sources of worry, and are sure that you are not going to have any for ten years to come, then you *may* not need research."

Owing to the wide range covered by the title of the paper, I have had to be very sketchy in parts and to glance over subjects which deserve more detailed treatment, but I trust I have been able to demonstrate the importance of science in the cable industry and to show that the industry itself is alive to this importance. British cables have always been in the front rank in the markets of the world and the British Cable Industry is seeing to it that this modern aid to progress, Industrial Research, is being fully used to ensure a continuance of that position.

FIG. 14.—Henley Laboratories. Chemical Laboratory.

DISCUSSION.

THE CHAIRMAN, in inviting discussion, said the author was a very modest person. The audience had hardly heard him mention that all the work which he had been describing had been organised and carried out under his own tuition and initiative, and with a long vision of what was necessary. This was not the first time that the electrical industry had been placed under a debt to Captain Dunsheath and the company with which he was associated by the manner in which they had placed at the disposal of others a great deal of information and knowledge which they had gained in the course of their own work. Personally, he hardly went so far as Capt. Dunsheath in saying that cable making in the past had been an art rather than a science, because he knew how much research had been done by other individuals and firms in that particular field to which Captain Dunsheath had referred. It was true to say that to a large extent the cable industry had started, and had been carried on up to a comparatively recent time, based on a wide experience and a summary of experiments which had failed and then succeeded. That was quite a different thing from saying that it had been founded on a precise scientific knowledge, to attain which was the object of Captain Dunsheath and others, who were now trying to reduce that ordered knowledge and ordered experimental work to more sure and certain knowledge.

He had been particularly struck by one little touch in Captain Dunsheath's paper, where he had referred to the trouble that arose the moment one began to make experiments, namely, what a number of new channels were opened up.

Captain Dunsheath had referred to a book of suggestions which he had. Personally he had suffered from the same thing. He himself had a large drawer in a file which was full of suggestions which he had noted down for future examination, discussion, and research, and which he intended to go into when he retired. As, however, the actuaries had informed him that he only had an expectation of life of about six years he had not the slightest idea how far he would be able to progress with the work. Nevertheless, he would urge Captain Dunsheath not to be discouraged by the many new problems which opened themselves up for investigation, because it was very remarkable how the facilities and abilities for carrying out experimental work were increasing in the present time. Experiments, which ten years ago would have taken twenty years to carry out, could now, owing to new apparatus and new methods and new knowledge, be carried out in a comparatively short time, and though one might never hope to overtake those channels which were being continually opened, he thought it was reasonable to say that one was nearer overtaking them now than ever before in the history of experimental work.

Captain Dunsheath had placed on the wall an enormous list of those occupations which fell on a research laboratory, and his listeners would agree with him when he said that no laboratory was going to be short of work in face of that list. There was one item, however, which Captain Dunsheath had not mentioned, namely, that there was a special department for mathematical research at Henley's works. Notwithstanding popular opinion to the contrary one could not get anything out of a mathematical process, anything which one did not put into it. Nevertheless, mathematical research, when one had some sound experimental data, was a very rapid way of arriving at results which might take a great many years if one had to cover the whole ground in laboratory research. Therefore, he felt that that was one of those departments which it was very wise to include in any organisation in order to make use of the experimental results which were obtained.

MR. ALAN A. CAMPBELL SWINTON, F.R.S. (Past Chairman of Council) said everybody would agree that the lecture had been a most interesting and instructive one. There was one particular point on which Captain Dunsheath had just touched in which he had always been interested. Captain Dunsheath had mentioned that copper of 113 per cent. conductivity had been obtained—he presumed by extreme refinements; and he had been much interested in the table given of the impurities in the material. He noticed that hydrogen was not mentioned. The matter was too long to go into on the present occasion, but anybody who had experimented to a considerable extent with high vacua, as he had done, must believe that the presence of hydrogen in metals had an enormous effect on their properties—far greater than was imagined. He understood that the latest theory with regard to diamonds was that the difference between a diamond and graphite was entirely a matter of hydrogen. The diamond was a carbon with no hydrogen in it, and graphite contained hydrogen. Anybody who had experimented with vacuum effects knew that it was almost impossible to get rid of hydrogen from metals. It would be very interesting to know if any attempts had been made to see to what extent the conductivity of pure copper could be improved by the elimination of the hydrogen.

MR. MARTIN HOCHSTADTER said the ideas and methods adopted in the matter of high tension cables not only differed among engineers of different countries, but differed among the engineers of any one particular country. Especially was that the fact in regard to measuring apparatus. The standard for measuring the power factor in power cables differed in every country, and in that respect he pleaded for

international exchange of views so that the best qualities of each country's standard could be taken and united into one common and the best standard.

Mr. G. L. Addenbrooke said it was generally recognised that the construction of cable was founded on electrical science. On the other hand, he did not think it was generally recognised how much electrical science itself owed to the cable industry. In the course of his work he had had to study the views of people like Maxwell and Kelvin, and it was perfectly clear to him that the work of Maxwell could not have been done but for the work which had been previously carried out in the cable industry. It was really the cable industry that had put the electrical industry on a quantitative basis. It was not difficult to see that. There was a book published in 1856 by De la Rive, which practically covered the electric field. If one read that book and then turned to Maxwell, one found that what came between was work on cables, and it was the work on cables, and the way that work was put into shape by a Committee of the Board of Trade—which had been formed when there had been a vast breakdown of cables and when it looked as though the industry might come to a stop altogether—which had really put electricity on a quantitative basis. It was at the request of the cable industry that the British Association started their work on electrical standards, and, as he had already said, there was no doubt that that was the basis to which Maxwell looked for data. For some time after this period the question of dielectrics had taken rather a prominent place in the minds of scientific men. It was interesting to notice that general dielectric theory had progressed very little during the last twenty-five years. What was in the text books now was practically in the text books of thirty years ago. There was no general consensus of opinion beyond what was in the text books. But in the meantime, during the whole of that period, a vast amount of research work had been done by manufacturing and distributing companies all over the world. Very little had been done, however, in co-ordinating that work, and a great deal of it had been done over and over again, and was likely to continue to be so done, and much more expensively than it need be done, unless certain of the more fundamental principles were better known. He thought more attention should be devoted to those general principles.

He mentioned that because the Author had said, quite rightly, that a works research laboratory should devote itself largely, at any rate at present, and for some years to come, to the problems immediately arising out of the work before it, but he was quite certain that enormous help in solving a good many of those problems could probably be got now by a very moderate amount of research on fundamental principles. A stage had now been reached in electrical work when there was doubt about a certain number of points, which, if they could be solved, would clear the way for solving others, and for advancing industry generally. There was no doubt that if the work of such laboratories went on for some years, and if from time to time those who had charge of them were able to give to the world the results of their researches, they would greatly help the general advance of science, and enable many things to be done which could not be accomplished at present.

Mr. W. H. Patchell (Past President of the Institution of Mechanical Engineers), in the course of some complimentary remarks, said he wished more had been said about cables. It was generally believed that the fault lay in the joint of a cable, but he had in his hand figures from America of faults on 1,000 miles of high tension cable—anything from 20,000 to 45,000 volt cable—and there were more faults in the cable than there were in the joints. It had been a revelation to him that

such things were happening. They would continue to happen until the industry got from men like Captain Dunsheath what dielectrics really were, and what were the ill effects of air in the cable.

Mr. W. C. Smith (Anchor Cable Works), Mr. D. A. Porteous and Mr. Fred Plutte also expressed their appreciation of Captain Dunsheath's paper.

Mr. T. N. Riley differed from the author as regarded his view that fundamental research had no part in a works organisation. That might not be the main business, but he did not think one could get very far, particularly with regard to any new developments, unless fundamental research was carried on, especially, perhaps, in the direction of dielectrics. Mr. Höchstadter had referred to the desirability of a comparison being made between the methods of measurement in different countries, largely, he thought, in the direction of the measurement of the dielectric loss. That had already been done to some extent. In the laboratories of his own firm, Standard Telephones and Cables, Ltd., they had carried out tests by several different methods of measurement—some of those in use on the Continent, and others in use in this country and America—with a view to determining whether there were any essential differences in the results obtained by different methods, or whether exactly the same loss measurements could be accurately made by any of the methods, provided suitable corrections were made. Up to the present tests had been completed on three methods, and it had been found that exactly the same power factors could be determined by all three; so that the criticism which had been made in a discussion on a previous paper by Captain Dunsheath—that the customer was entirely in the hands of the cable maker as regarded loss measurements—was, to some extent, met, since adequate proof of accuracy could be given.

The Chairman, in moving a hearty vote of thanks to the author for his paper, said the audience would go away inspired by the fact that real efforts were being made in the cable industry, at least, not only to place the empiric knowledge to which the author had referred on a scientific basis, but to push it into new fields, and that progress, which was what the cable industry and all other industries required, was assured.

The vote of thanks was carried unanimously.

Captain Dunsheath, in acknowledging the vote, paid a tribute to his staff.

Sir George Sutton, Bt., then proposed a hearty vote of thanks to Mr. Llewelyn Atkinson for presiding. In doing so he said that Mr. Hochstadter had spoken of co-operation in research. When he, Sir George, had been a young man he used to think an inventor was a man who invented something for the good of the world generally, but did not make anything out of it himself, and that had been true of inventors up to the middle of last century; they had worked for the love and pleasure of their occupation. Things were different to-day, however. There was money to be got out of inventions besides pleasure, and there was, therefore, a tendency for men working on research to keep their discoveries to themselves, or, at any rate, for their employers to do so. The present paper, however, was one which had been prepared at the expense of an industrial trading company, which had put before the Institution of Electrical Engineers and the Royal Society of Arts some of the work which was being done in their laboratories; in other words, they were willing to co-operate with others for the advantage of industry

generally. Such a course must be to the especial advantage of the electrical industry. Every improvement that could be made in the distribution of electrical energy by means of cable or otherwise meant a great extension of the application of the use of electricity. It meant the cheapening of production, and that meant greater use. He was all in favour of co-operation in research. He refused no foreigner who came from abroad, or no electrician who came from the United States, admission to the works which he controlled, and he should like to see the same spirit prevailing elsewhere.

The vote of thanks was carried unanimously.

THE CHAIRMAN, in acknowledging the vote, said he could only hope that the suggestion thrown out by Mr. Hochstadter and supported by Sir George Sutton would fructify.

SIR CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., writes:—
"I should like to take this opportunity of adding my testimony to the high value of Mr. Dunsheath's paper in the field of research, whilst also congratulating his Company, as well as other land cable manufacturing Companies, on their pioneering enterprise, more especially in regard to paper insulation. Those engaged in the construction of submarine cables had always discouraged the very idea of paper insulation for any purpose, if only on account of the formidable difficulties that presented themselves in connection with joint making."

OBITUARY.

SIR KRISHNA GUPTA, K.C.S.I.—A telegram from Calcutta, announcing the death of Sir Krishna Gupta at the age of 75, was received in London on March 29th. Sir Krishna, who was born in Eastern Bengal in 1851, was the first Hindu to be appointed, in 1907, to serve on the Council of India, which shares with the Secretary of State the responsibility for the control of Indian policy. He came to England in the late sixties to compete in the Indian Civil Service examination, in which he was successful in 1871. After the customary two years probation, during which he was called to the bar of the Middle Temple, he was posted to his native province of Bengal, and at the beginning of his service gained valuable experience in the Bihar famine relief operations. He reached the grade of Magistrate and Collector in 1889 and in 1890 was appointed Junior Secretary of the Board of Revenue. This appointment led on to his selection for the Commissionership of Excise, and after serving on the Excise Committee appointed during Lord Curzon's Viceroyalty, he received, in 1905, one of the two memberships of the Board of Revenue for the Province of Bengal. In 1906 he was deputed to report on the development of the Bengal fisheries, and in the course of his investigations into the prospects of developing a fishing industry in Bengal he paid visits to the United States and to Europe.

It was during his visit to England in the above connexion that he came into close personal contact with the late Viscount Morley, who proposed and secured his appointment to the Council of India, of which he was a member for the full statutory period of seven years. Soon after his appointment he became, in 1908, a member of the Royal Society of Arts and performed valuable service on the Committee of the Indian Section. In 1909 he read a paper at one of the meetings of the Section on "Some Phases of Hinduism," for which he was awarded the

Society's silver medal, and during the period of his residence in this country he often attended the Society's Indian Meetings, occupying the Chair on one or two occasions and frequently taking part in the discussions.

After the termination in 1915 of his period of office on the Council of India, Sir Krishna, who had received the K.C.S.I. in 1911, continued to reside in England, interesting himself in Indian questions and especially in Indian female education. After the war he spent most of his time at Bangalore with his daughter, Lady Banarji, wife of the Dewan of Mysore.

James Henry Howell, J.P.—We regret to announce the death of Mr. J. H. Howell, at Clifton, on April 6th, at the advanced age of 85. Mr. Howell, who joined the Royal Society of Arts in 1901, was one of the leading citizens of Bristol, where, in addition to being Chairman of his own firm, Messrs. Llewellins and James, Brass-Founders, he was also Chairman of the Bristol Tramways and Bristol Gas Companies, and prominently connected with other public activities. He took a leading part in local philanthropic work, to which he gave not only money, but time and personal effort. His death removes one of the outstanding personalities in the commercial and civic life of Bristol.

Sir John McLeavy Brown, C.M.G.—Sir John McLeavy Brown, who became a Life Fellow of the Royal Society of Arts in 1900, died in London on April 6th, at the great age of 90. Born in County Antrim on November 27th, 1835, and educated at Belfast Academy and afterwards at Trinity College, Dublin, where he graduated M.A. and LL.D., he became by competitive examination a student interpreter in China in 1861. His exceptional administrative and diplomatic ability was quickly recognised, and in 1864 he was appointed Assistant Chinese Secretary to the British Legation in Pekin and was in charge of the Legation for a period in 1867. In 1868 he was permitted by the Foreign Office to accept the position of Secretary to the Chinese Mission to the United States and to various European countries, which concluded the famous Burlingame treaty between China and the United States. In 1870, when the Burlingame Mission came to an end, he rejoined the Legation at Pekin, but resigned in 1872 to join the Chinese Customs Service, of which in 1898 he became head. Soon afterwards he was appointed Controller of Finance in Korea, and under very difficult conditions at a time when China, Japan and Russia were all struggling to get the upper hand in Korea, he succeeded in restoring the disturbed finances of the country to some degree of order, and also introduced some measure of sanitation into the exceedingly dirty town of Seoul. Mr. Brown resigned his position in Korea in 1906 and was subsequently appointed Counsellor of the Chinese Legation in London. In 1898 he received the C.M.G., and the honour of knighthood in 1906, as well as during the course of his long and distinguished career, many high Chinese, Japanese and Korean decorations.

NOTES ON BOOKS.

The History and Romance of Piccadilly and Mayfair. By Percy Rudolph Broemel, Fellow of the Royal Society of Arts. London: T. B. Mills. *1s. 6d.* net.

The author has been inspired by the success of his previous publication, "The History and Romance of Cavendish Square and its Vicinity," to treat the Piccadilly and Mayfair district in a similar manner. Londoners are notoriously ignorant

of the history and associations of their city, and it may safely be said that not many dwellers in Mayfair are aware that the origin of the name of that fashionable quarter dates, at any rate, as far back as the time of Edward the First, who granted to the Leper Hospital, occupying the present site of St. James' Palace, "the profits of a Fair to last from the Eve of St. James (May Day), the day and the morrow following and four following days." The Fair appears to have been originally established for the sale of live cattle, leather, and goods, but later on, in the time of James II., it is spoken of as being held "not for trade or merchandise, but for musick, showes, drinking, gaming, raffling, lotteries, stage-plays, and drolls."

Mr. Broemel has packed a great deal of such-like interesting information, together with a number of good stories, in the fifty pages of his book, which should be of considerable use to American and other visitors to London. One of the stories may be quoted as a sample of the others. It is told of the famous Sheridan, who, upon his father's regretting that the "O'" had been dropped from the family name, remarked: "And it would be so appropriate to us as we owe every body!"

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, APRIL 19.. Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. General Meeting.

Electrical Engineers, Institution of, at the University, Liverpool. 7 p.m. Prof. Dr. S. P. Smith, "An All-Electric House."
At the Cleveland Technical Institute, Middlesbrough. 7.15 p.m.

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Dr. Vaughan Cornish, "Harmonies of Tone and Colour in Scenery determined by Light and Atmosphere."

Transport, Institute of, at the Queen's Hotel, Birmingham. 6 p.m. Annual General Meeting.

East India Association, at the Caxton Hall, Westminster, S.W. 3.30 p.m. Commissioner F. Booth-Tucker, "The Criminal Tribes of India."

TUESDAY, APRIL 20.. Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. L. H. Dudley Buxton, "Ethnic Relations in India and the Near East."

Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8 p.m. Mr. H. S. Rowell, "Experiments on Lamirated Springs."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. W. Griffiths, "Bearing Metals."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Barcroft, "The Spleen."

Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Mr. H. W. Macrosty, "Statistics of British Shipping."

Transport, Institute of, at Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. P. H. Price, "The Railway Clearing House."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Monsieur Charles Fabry, "The Photographic Plate as a Measuring Instrument for Visible and Invisible Radiations."

WEDNESDAY, APRIL 21.. Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Major E. I. David, "Electricity in Mines."

Geological Society, Burlington House, W. 5.30 p.m. 1. Mr. L. R. Cox, M.A., F.G.S., "*Anthracopupa britannica* sp. nov., a Land Gastropod from the Keele Beds of Northern Worcestershire." 2. Mr. H. P. Lewis, M.A., F.G.S., "On *Bolopora undosa* gen. et sp. nov.: a Rock-Building Bryozoan with Phosphatized Skeleton from the Basal Arenig Rocks of Ffestiniog (North Wales)." 3. Dr. C. A. Matley, F.G.S., "The Geology of the Cayman Islands (British West Indies), and their Relation to the Bartlett Trough." Sir T. W. Edgeworth David, K.B.E., C.M.G., D.S.O., F.R.S., will exhibit lantern-slides illustrating the proposed new deep boring on the Great Barrier Reef, off Cairns (Queensland).

Hygiene, Institute of, 28, Portland Place, W. 3.30 p.m. Col. A. H. Tubby, "Preventable Deformities during Childhood and Adolescence."

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. Dr. J. Glasspoole, 1. "The Driest and Wettest Years at Individual Stations in the British Isles, 1868 to 1924." Mr. C. E. P. Brooks, 2. "The Meteorological Conditions during the Glaciation of the present Tropics, being some remarks on the climatological basis of Wegener's theory of Continental Drift." and 3. "The Variations of Pressure from month to month in the region of the British Isles."

THURSDAY, APRIL 22.. Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 6.30 p.m. Captain G. T. R. Hill, "The Tailless Aeroplane."

Chemical Society, Burlington House, W. 8 p.m. Mr. W. C. Reynolds, "An Analysis of the Ether. Part II. The Magnetic Fields in Atoms."

China Society, at the School of Oriental Studies, Finsbury Circus, E.C. 5 p.m. Mr. W. Perceval Yetts, Origins of Chinese Art."

Constructive Birth Control, at the Essex Hall, Essex Street, Strand, W.C. 8.15 p.m. Lord Morris and Dr. M. Stopes, "Debate on Birth Control."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Sir J. J. Thomson, "The Mechanics of the Electric Field."

Historical Society, 22, Russell Square, W.C. 5 p.m. Sir Richard Lodge, "A Derelict Diplomatist in the 18th Century."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. O. H. P. Prior, "Anglo-Norman Literature."

FRIDAY, APRIL 23.. Mechanical Engineers, Institution of, Storey's Gate, St. James' Park, S.W. 7 p.m. Mr. F. J. Hookham, "What our Foreign Competitors are Doing."

Metals, Institute of, at University College, Singleton Park, Swansea. 7.15 p.m. Annual General Meeting.

Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m. Prof. Charles Fabry, "The Absorption of Radiation by the upper atmosphere."

Royal Institution, 21 Albemarle Street, W. 9 p.m. Prof. R. Whiddington, "Luminous Discharge through Rare Gases."

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. S. Turner, "An Explorer in the New Zealand Alps."

SATURDAY, APRIL 24.. Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. W. T. Calman, "The Shipworm." (Lecture II.)

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Royal Society for the Encouragement of Arts, Manufactures, and Commerce.

The Royal Society of Arts was founded in 1754, and incorporated by Royal Charter in 1847, for the Encouragement of the Arts, Manufactures, and Commerce of the country.

At present the Society numbers about 3,500 Fellows. The annual subscription is Three Guineas, the life subscription Thirty Guineas. There is no entrance fee.

Fellows are entitled to be present at all meetings of the Society. These include the Ordinary Meetings, held every Wednesday during the Session, when papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed; the Meetings of the Indian and Colonial Sections, at which subjects connected with our Indian Empire and the Colonies and dependencies are considered, and the various lectures on technical subjects delivered under the Cantor and other trusts. Fellows also receive a weekly copy of the *Journal* which contains full reports of the Society's proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce; and they are entitled to the use of the library and reading room.

Proposal forms and further particulars relating to the work of the Society, may be obtained from the Secretary, Mr. G. K. Menzies, at the Society's House, John Street, Adelphi, London, W.C. (2).

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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FRIDAY, APRIL 23rd, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, APRIL 26TH at 8 p.m. (Cantor Lecture.) CHARLES REED PEERS, C.B.E., M.A., Director, Society of Antiquaries, Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." (Lecture II.)

WEDNESDAY, APRIL 28TH at 8 p.m. (Ordinary Meeting.) JAMES PATERSON, M.C. (of Messrs. Carter, Paterson and Co., Ltd.), "Horse Traction and Motor Traction." SIR HENRY P. MAYBURY, K.C.M.G., C.B., M.Inst.C.E., Director-General of Roads, Ministry of Transport, will preside.

COUNCIL.

A meeting of the Council was held on Monday, April 12th. Present:—Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair; Sir Charles H. Armstrong; Sir Frank Baines, C.V.O., C.B.E.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Major Sir Humphrey Leggett, D.S.O., R.E.; Sir Charles C. McLeod, Bt.; Sir Philip Magnus, Bt.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas; Professor J. M. Thomson, F.R.S.; Dr. J. Augustus Voelcker, M.A., Ph.D.; and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary) and Mr. W. Perry, B.A. (Assistant-Secretary).

Sir Herbert Jackson, K.B.E., F.R.S., was elected a Vice-President of the Society in place of Captain Sir Acton Blake, K.C.M.G., K.C.V.O., deceased.

The number of entries for the March Examinations was reported—27,160. Two further series of Examinations will be held this year, in May and July.

Arrangements for the decoration of the rear wall of the Society's House facing the Strand, were approved. (A further statement on this subject will appear in a subsequent issue of the *Journal*.)

The question of the award of the Albert Medal for 1926 was further considered.

Sir John Biles, K.C.I.E., LL.D., D.Sc., and Captain Sir Arthur Wellesley Clarke, K.B.E., were appointed members of the Thomas Gray Memorial Trust Committee.

Papers and courses of lectures for session 1926-7 were considered.

Other formal and financial business was transacted.

FIFTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 14th, 1926. SIR FRANK WARNER, K.B.E., Chairman of the Central Committee for the Competition of Industrial Designs, in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

Achariar, T. M. Daivasikhamani, Washermenpet, Madras, India.
Adeeb, Emile, London.
Benzie, George William Gledhill, Udarband, Cachar, India.
Bledisloe, Rt. Hon. Lord, K.B.E., London.
Brough, Thomas, J.P., Halstead, Essex.
Clarke, Captain Sir Arthur Wellesley, K.B.E., London.
De Silva, K.G.C., Colombo, Ceylon.
De Zoysa, Garumuni Arthur, London.
Faizuddin, Saiyid, Nagpur, India.
Fergusson, John Carlyle, B.A., I.C.S., Agra, India.
Hughes, The Rev. Robert, Ph.D., D.C.L., Llandudno.
Knight, Hugo Sidney, London.
Lannon, John D., Buffalo, New York, U.S.A.
La Wall, Charles H., Sc.D., Philadelphia, Pa., U.S.A.
Lupton, John Thomas, LL.D., Chattanooga, Tennessee, U.S.A.
Northumberland, His Grace The Duke of, K.G., London.
Zilen, Victor W., Buffalo, New York, U.S.A.

The following candidates were duly elected Fellows of the Society:—

Beinecke, Fritz W., Madison, New Jersey, U.S.A.
Davidson, John Marcel, Salisbury, Rhodesia.
Ditcham, Vernon, L.D.S., North Berwick.
Gill, Frank, O.B.E., M.I.E.E., London.
Jackson, P. S., M.I.E.E., Calcutta, India.
MacCormick, Sir Alexander, M.D., Sydney, Australia.
Murad, Professor F. D., Aligarh, India.
Olliver, A. M., London.
Paterson, Clifford Copland, Wembley, Middlesex.
Powell, Albert Richard, Kempston, Bedford.
Singha, Prufulla Kamal, Bhagalpur, India.

A paper on "Art Training for Industry and the Society's Competitions" was read by Mr. R. A. Dawson, A.R.C.A., Principal, Municipal School of Art, Manchester. The paper and discussion will be published in the *Journal* dated May 21st.

JOINT MEETING OF INDIAN AND DOMINIONS AND COLONIES SECTIONS.

Friday, April 16th, 1926. Mr. Arthur Michael Samuel, M.P., Parliamentary Secretary, Department of Overseas Trade, in the Chair.

A paper on "The Work of the Imperial Institute" was read by Lieut.-General Sir William T. Furse, K.C.B., D.S.O., Director of the Imperial Institute.

The paper and discussion will be published in the *Journal* dated May 28th.

CANTOR LECTURE.

Monday, April 19th, 1926. Mr. Charles Reed Peers, C.B.E., M.A. Director of the Society of Antiquaries, Chief Inspector of Ancient Monuments, H.M. Office of Works, delivered the fist of his course of three lectures on "Ornament in Britain."

The Lectures will be pubiished in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 10th, 1926.

Dr. R. Lessing, Ph.D., M.I.Chem.E. in the Chair.

Dr. R. Lessing, who presided in the absence of Sir Thomas H. Holland, Chairman of the Council, in introducing Dr. Reinhardt Thiessen, said many of those present would know the lecturer by his work on the micro-structure of coal. Dr. Thiessen was at present working at Sheffield University under an arrangement of exchange with the American Bureau of Mines.

The following paper was then read:—

THE MICRO-STRUCTURE OF COAL

By Reinhardt Thiessen, Ph.D., of the Bureau of Mines, United States Department of Commerce.

Coal is easily one of the most, if not the most, important mineral turned to the benefit of man. There are other similar valuable products such as shale oil, petroleum, natural gas, and wood; but these are only temporary and supplementary; coal is the foundation and mainspring of present civilization.

The efficiency with which we use coal and the power derived from it is an index to our social, scientific, and industrial progress. It should, therefore, be of interest and value to learn as much as possible about this important substance; let us hope that through a greater knowledge of its chemistry and composition its value may be increased and its service lengthened.

Our topic to-night is "The Micro-Structure of Coal." Let us make the topic somewhat broader, however, and first discover how coal came to exist, what plants contributed, how and where they grew, and after death and decay what remained of them, and how this residue finally turned into coal. The best way to learn the construction of a clock is to examine it from the outside from all angles and then gradually look further and deeper into the mechanism and then take it apart wheel by wheel and piece by piece and learn how each piece is made. In a similar manner let us get at the structure of coal and after we are through with it let us hope that we know more as to what coal is.

We will take into consideration mainly the ordinary bituminous coals such as we use every day in the household fires, in the factories and under the locomotive boilers. We must, however, be brought to realize that there are several kinds of coal, such as the ordinary coal, cannel coal, boghead coal, etc., and a good many ranks of coal such as peat, brown coal, lignite, sub-bituminous, bituminous, sub-anthracite and anthracite, with many grades between each. These can be arranged in order of sequence chemically, physically and as to efficiency in such a way that the difference of one to the one next it is so small as to be hardly noticeable. Occasionally all the ranks of coal may be found in one and the same bed and may be encountered in passing from one end of the field to the other. More often, however, the different ranks are to be found in widely separated fields and geological horizons. This leads us to assume the peat to anthracite theory of coal formation, that is, that any coal was laid down as peat in a similar manner to that in which the peat of to-day is being formed.

PEAT FORMATION.

Peat is formed in shallow or undrained basins, depressions or plains where conditions for a luxurious plant growth are favourable, and where there is a water level high enough to insure complete submersion and thus prevent complete decay and make possible an accumulation of the semi-decayed plant substances. Such areas are called swamps or bogs according to the prevailing conditions. Many types of swamps and bogs exist, such as the marsh, fen, moor, and wooded swamp. The most important for our consideration is the wooded swamp, as it is, according to all observations, the one most analogous to the swamps which gave rise to the ordinary coals. Many such swamps exist, particularly in the temperate zone. In the United States, especially in the states of Minnesota, Wisconsin, and Michigan thousands of acres are covered with these swamps. The Dismal Swamp of Virginia and North Carolina is also a good example. The vegetation in these swamps consists of a dense

growth of moisture-loving trees, such as the white cedar, tamarack, balsam, bald cypress, black ash, black gum, and a few others. However, only a few species grow together in a given swamp, and of these one predominates. We thus speak of the cedar swamp, the tamarack swamp, or the cypress swamp, because the trees after which the swamp is named predominate in that swamp, being associated with only a few of any other species. Shrubs and herbaceous plants are absent or but scantily represented; but a thick carpet of moss and lichens covers the hummocks, fallen tree trunks and the lower parts of the living trees.

The ground, under these conditions, is very wet, and submerged for the most part during the wet season, so that only the higher places or hummocks are out of the water, and these are thoroughly soaked even during the driest periods.

Few trees maintain their erect positions. Owing to the loose substratum many trees are found reclining at all angles, and from year to year lean over more and more until finally they lie flat on the ground. The wildest entanglement therefore exists which in some parts is almost impenetrable. On the ground we find a number of trees and tree trunks either on top of the ground or partially submerged in a wild array. Between these is an entanglement of dead limbs, branches and twigs on the surface or partially covered up, and between these again a litter of leaves and fragments of woody matter, all in a more or less decayed condition.

How and What the Plants Contributed.

Every tree, no matter whether evergreen or deciduous, sheds its foliage once every year. The total amount contributed by this alone is very large. Besides the leaves, trees shed every year a considerable part of their small twigs, contributing in this way a considerable amount of woody material. Also, as a natural sequence of growth, a par' of the bark is shed throughout the year. Spores, pollens, seeds, and scales, though relatively small in amount, are important contributors every year. Secondly twigs, branches, and the larger limbs are torn off by wind, snow and sleet; occasionally whole trees are blown over. Twigs and branches and even whole trees may be injured and die, and these owing to decay sooner or later fall to the ground. The ground on which the trees grow, being very loose, provides an insecure hold for the roots, and the trees lean over more and more till finally they lie flat on the ground and are covered up either dead or alive by the debris of the following years.

Immediately after the death of the plant, when those functions which protect the plant from the ravages of parasites and saprophytes cease, it becomes a host to both bacteria and fungi. As long as the plant matter remains in the air and in a moist condition decay proceeds rapidly. Much of it decays completely, but a considerable portion remains in a semi-decayed condition. This part is reduced to all degrees of maceration.

Gradually as the debris of years is added, the debris of former years is buried deeper and deeper, the air becomes more and more excluded and decay slows up. Fungi cease to be able to exist and bacteria alone are active. Finally the debris becomes heavily covered up and comes to lie in a stratum below the average waterline. Air is now entirely excluded and anaerobic bacteria alone can exist.

Plant substances vary greatly in respect to resistance to decay. Some substances decompose very readily, others not at all. Those substances which compose the living parts of the plants and those that serve as plant foods, as protoplasm, protein, sugars, starches, and gums, decompose relatively easily in a relatively short time, and very little remains of them when exposed under favourable conditions. Components of the cell walls are more resistant; but these in themselves vary greatly in the ease with which they are decomposed. Hemi-celluloses, hexoses, and pectins decompose more readily than does cellulose. Lignin resists decomposition more than does cellulose. Thus when wood is left to rot the cellulose, pectins, xylans, and pentosans will have almost completely disappeared in relatively few years, while the lignin, fats and resins will have almost entirely remained.

The protective substances such as the so-called cuto-cellulose and the higher fats and waxes of which the cuticles, spore and pollen coats are composed are extremely resistant to decay. The waste products such as resins, terpenes, alkaloids, and others are also not putrefiable.

Because certain products present in only relatively small amounts decompose with great difficulty, and other products constituting the bulk of the plant mass are readily decomposed and disappear to a large extent, the former are concentrated and are found in many times larger proportions than in the plant originally. There is thus going on all the time an elimination of the more easily decomposable substances and a concentration of the more resistant materials.

It is also known that the wood of certain species is more readily subject to decay than that of others. The wood of the spruce and balsam rots less easily than that of the black ash, and the wood of the tamarack less easily than that of the spruce, and that of the white cedar less easily than that of the tamarack. In the same swamp the stem of the black ash may be reduced to a debris while that of the cedar may be in a firm and sound condition. Also the heart wood of a tree is more resistant to decay than the sap wood. It has been found that an extract of the heart wood is more toxic than that of the sap wood, and it is believed that the degree of resistance to decay depends upon the toxicity of the wood.*

As already mentioned, a number of trees are buried alive. Furthermore, although the root complex of the flora of a swamp never penetrates far into

* L. F. Hawley, L. C. Fleck, and C. A. Richards—J. Industrial and Engineering Chemistry (1924); **16** p. 699.

the substratum, remaining relatively near the surface, yet by the time the trees die it is covered by a considerable stratum of peat. There is, therefore, a considerable amount of contributing plant material buried alive. This cannot be attacked by fungi but by bacteria only. Under these conditions it is not known how far either the lignin or the cellulose decomposes.

THE DEPOSIT.

Having obtained an idea of the kinds of plants contributing to the bog, how they contribute and the manner of their decay, and of the composition of the surface and the surface layer, it should not be difficult to get an idea of the structure and composition of the deposit itself.

A casual observation of the surface has shown us a profusion of fallen trees and tree trunks and their parts. Between these is a litter of twigs, branches, strips of bark, leaves and needles. Most of this matter is already in an advanced state of decay. A close up view shows us the importance of leaves, twigs, needles, and fragments of woody matter. In digging into the deposit the same constituents are met with in a more advanced state of decay. The real peat is found at a depth of a foot or two below the surface. An examination of the deposit from top to bottom shows that it was all built up in a similar manner and from the same kinds of material.

The whole mass is very wet, containing up to 85% water. It may easily be dug with a spade, and all the woody components including the logs may be easily cut with the spade and moulded like clay. The spaces between the larger components are filled with a fine black mud. When this is examined under the microscope it is shown to consist, not of earthy material, but of the degradation matter of everything and anything that the plants had produced.

The best idea of the composition and structure of peat may be obtained in the dry state. For this purpose a mass of peat should be removed from the deposit at some depth without disturbing the original relationship of any of the constituents and the block allowed to dry slowly under some pressure.

In examining a lump of peat thus dried it is found that by far the largest part is derived from the woody parts of plants. These woody components are in the form of definite fragments ranging in size from that of a good sized log to such only visible under the microscope. The original plant structure has invariably been preserved to a greater or less degree.

The woody fragments are packed or embedded in a more finely macerated mass. This is the part recognized as the black mud in the wet peat mass and as it is composed of macerated plant matter it is called the attritus. Roughly, then, the lump of peat may be separated into the constituents derived from wood and the more finely divided mass, the attritus. The attritus is the ground mass or that in which everything appears to be embedded. Examining it more closely one finds a large part of it to be derived from the woody parts of plants of much the same chemical composition as that of the larger wood

fragments. Further, there can be distinguished macerated leaf tissues, bark, cortex, pith, spores, pollens, resins, fragments of the tissues of mosses and lichens, some mineral matters and a few other constituents.

Besides the constituents visible to the naked eye or under the microscope, a number may be detected by chemical methods. Among these may be mentioned oils, waxes, volatile oils, terpenes, alkaloids and glucosides.

All of the constituents may be easily traced through all the ranks of coal from brown coals to anthracites, and in all of these are alike, constituent for constituent. Those components derived from the woody tissues, to designate them by one term, are called anthraxylon and the finely macerated components, including a large variety of derivatives together, constitute the attritus throughout.

In the manner just described we have good reason to believe that the ancient peat bogs that gave rise to the present coals were formed.

The Coalification Process.

The ancient bog was gradually covered up with silt, sand, and clay, which later metamorphosed into rock, while the peat itself was gradually changed into coal of the rank, according to the time and intensity of the coal-forming process, in which it is found to-day. An anthracite went through all the ranks : brown coal, lignite, sub-bituminous, bituminous, semi-anthracite and then finally into anthracite. Bituminous coals went through all the ranks up to bituminous coal, and so on for the rest. Given the required time and proper conditions the brown coals will change into coals of higher ranks.

The factors which determined the rank of a coal are generally assumed to be the geological period during which the coal was laid down, the pressure and the temperature.

Periods of Coal Formation.

There were three main periods during the earth's history, during which conditions were particularly favourable for the accumulation of plant material which has since been converted into coal. By far the most extensive accumulation took place during the close of the Palaeozoic era. During this time most of the important coals of Europe, North America and China were laid down. The second occurred during the Cretaceous times during which the coals of the eastern slope of the Rocky Mountains were formed. The third occurred during the Tertiary times when the brown coals of Europe and the Lignite of the southern part of the United States and the Western Rocky Mountains were formed. Only relatively small amounts of coal were laid down during other geological periods.

The kind of plants from which the coal was formed probably had also something to do with the kind of coal, but had probably very little to do with its rank. The kinds of plants that contributed to the Palaeozoic coals belonged

to totally different families from those that gave rise to the Cretaceous or the Tertiary coals. The coal measure plants consisted chiefly of Calamites, Lepidodendrons, Sigillaria, Sphenophylls, certain Cycads like Gymnosperms, and the Cordiates, now either extinct or represented by small plants. The plants contributing to the Cretaceous and Tertiary coals were much like the plants of to-day. The largest proportion appear to have been conifers, some of them very closely related to certain conifers living to-day. Although the families to which the plants belonged during the range of geological periods may have differed widely, their chemical composition is believed to have been quite similar.

Although the time during which a coal was laid down has much to do with its rank, it is by no means the only important factor. Earth movements or earth thrusts, which were accompanied by great pressures and raised temperatures, and depth of burial which is also accompanied by an increased temperature, approximately 1 degree for every 70 feet of depth, were the main factors in the transformation of the plant substances into the higher ranks of coal. Time will not permit to discuss the question further than to say that the more a coal has been subjected to earth thrusts and the deeper it has been buried the higher is its rank. The English coals are deeply buried and lie between rocks considerably disturbed and are of a high rank. The coals within the Alleghany mountains of America lie between rocks very much folded and are anthracitic. Certain coals of the Cretaceous of North America occurring in beds that extend from the western plains into the Rocky Mountains begin on the eastern border of the field as low-grade lignites, and going westward into the mountains gradually change into coals of higher ranks, ending in anthracites on the western border of the field, all in one and the same deposit. Again in Russia, near Moscow, occurs a coal in the Lower Carboniferous with a light cover and in an undisturbed region. This coal is a lignite. A coal in the very same horizon, but in Switzerland, and hence much folded and squeezed, is of the nature of graphite. Many more examples of a similar nature might be given.

The more important characteristics that mark the differences of the ranks of coal as one goes from the lower to the higher ranks are the increase in carbon content, decrease in oxygen content, and decrease in volatile matter as shown in the following table.

Substance.	C. %	H_2 %	O_2 %	N_2 %
Wood	50	6.0	43	
Lignin (Schwalbe)	55.6	5.8	38.4	
Lignin (Konig)	64.85	4.86		
Lignin (Klason)	66.67	5.40		
Lignin (Fischer and Schrader)	64.70	5.68		
Peat, wooded, Wisconsin	58.88	5.00	33.10	2.58
Brown coal, Saxony	64.4	6.6	29.0	

Substance.	C.	H_2	O_2	N_2
Coal, Carboniferous lignite, Moscow, Russia	70.0	6.3	20.9	2.10
Lignite, Burlington, North Dakota ..	70.97	4.35	23.10	1.16
Lignite, Williston, North Dakota	72.68	5.11	19.74	1.31
Subbituminous, Montana	76.94	5.55	13.25	1.89
Coal, bituminous, Illinois, Franklin county	81.37	5.37	10.10	1.91
Coal, bituminous, Upper Freeport, Pa. ..	83.13	5.35	7.80	2.19
Coal, bituminous, Barnsley bed, England ..	84.5	5.3	8.7	
Coal, bituminous, Pittsburgh bed, Bruceton Pa.	84.57	5.39	6.94	1.72
Coal, bituminous, Parkgate bed, England	85.1	5.1	6.3	
Coal, bituminous, Alabama	86.54	5.42	5.13	1.54
Coal, bituminous, Somerset County, Pa. ..	88.59	4.53	2.57	1.35
Coal, bituminous, Busty bed, England ..	88.8	5.0	3.9	
Coal, bituminous, Tioga County, Pa. ..	88.98	4.86	3.08	1.62
Anthracite, Schuylkill County, Pa. ..	92.91	3.09	2.41	0.91

Other characteristics are increase in hardness, gloss or light-reflecting properties, resistance to chemical reagents, and increase in efficiency. These differences in character in going from one rank to the next may be so slight as to be unnoticeable. There is no hard and fast line to be drawn between them.

As we see it in the coal bin, coal does not appear to possess any qualities that might arouse our æsthetic nature. It is merely an ugly, black sooty pile of homely lumps covered with grime. However, when we pick up a lump and brush the dirt away and examine it more closely there is much to arouse our interest and the closer we look the more interesting it becomes. It makes little difference from what bin, from what seam or from what country a piece of coal has been selected for observation as long as it is ordinary bituminous coal ; the main facts to be observed are the same for all.

Microscopic Appearance of Coal.

In looking over a number of chunks of coal in a pile it will be noticed that the blocks tend to have a prismatic shape. Two of the surfaces of the blocks have been produced along the bedding planes of the coal. Coal cleaves or splits more easily along these planes than in any other directions and we will call these the horizontal cleavage surfaces. These two surfaces tend to be parallel to each other. Next we notice two surfaces that also tend to be parallel to each other and which may cut the horizontal cleavage surfaces more or less at a right angle. These are called the face sides. Finally we have the two other sides of the block which are more irregular. They may be planes or they may be rough breaks, and when planes tend to be parallel to each other, but rarely at right angles to the cleavage surfaces. More often they are just irregular fractures. These are the butt ends of the coal. In examining a block you will also notice a number of cracks or spits or checks running approximately parallel to any of the surfaces. When striking the lump it is very apt to break along these cracks. These cracks or checks already exist to a large extent in

the seam and are of great importance in coal mining, to a large extent determining the lay-out of the mine. The cause of these checks is discussed a great deal by the physical geologist.

The next property to be observed is a peculiar lustre. This property is due to the physical or colloidal nature of the coal and depends upon the light-reflecting nature of certain constituents of the coal. The intensity of this property is in general a measure of the state of metamorphism of the coal; the higher the rank, up to a certain stage, the higher the gloss.

The Lamination or Layering of Coal.

We come now to the most important characteristics of the block, its layering or lamination. Any seam or bank of ordinary bituminous coal is readily seen to be highly laminated or stratified ; likewise a block of coal is seen to be laminated and compiled of various layers and sheets differing from one another in colour, texture, and fracture and varying greatly in thickness. At a casual observation one recognizes at once various larger jet-black bands of varying thicknesses. On closer examination there are seen to be present bands of all thicknesses from such only visible with the microscope to such easily seen and up to an inch or more in thickness. These bands almost always terminate in a knife-like edge. The smaller ones may lie wholly within the block, while the larger ones often run clear across the block ; but in the coal bank they can easily be followed to their termination and often must be followed for a considerable distance, many feet perhaps. All possible sizes up to a hundred feet or more in length and several inches in thickness are to be met with. If now we had an opportunity of splitting up a coal bank as it is actually done in stripping pits, we should have before us patches of greatly varying sizes, some broad, some narrow, some long, and some short, some irregular, oval, or in fact any form possible, some even branching. The majority, however, would be long strips, and relatively small. On the surface we should find the imprints of some plant structure, and we should soon realize that they were stems, logs, pieces of wood branches, or twigs turned into coal. Such in fact they are in a very much flattened condition.

Coming back now to the block of coal, we realize that the thicker black bands are merely short pieces of much larger, longer, and broader bands. Between these thicker bands lie the thinner bands that often terminate within the block. Looking at the block with a hand lens we discover that still thinner bands exist, and that these thinner bands are separated by or are embedded in a matrix of duller appearance, often of a greyish colour.

Having learned the appearance of the vertical faces of the block, let us now for a moment examine the horizontal cleavage surfaces. Almost any coal will split quite easily along the bedding planes. On examining the surfaces produced by splitting the coal horizontally a number of interesting marks are often to be seen. The most common and the most important of these are a

varying number of patches showing woody structure, surrounded by more or less structureless areas. These patches vary considerably in form and area. In size they may vary from a tiny speck to such that cover the entire surface. Many are of about the size of a postage stamp. These patches are the same as those we would have met with in the strip pit, only that they are the smaller ones.

The shape of these patches tends to be rectangular, and the two borders parallel to the direction of the woody fibres tend to be straight and parallel to each other. The ends are more or less irregular. Rounded or irregular forms may also be common.

The patches represent solid masses of constituents on one side of the split surface, while on the other they are merely impressions. On cutting into the patch a thin glistening sheet of coal is seen beneath the surface. This is also seen in a fracture somewhat oblique to the surface. With a light treatment with Schultz's reagent these constituents may be removed from the lump as thin scaly fragments, usually bearing woody structures on either side. On breaking they reveal glistening matter inside. One is sure, therefore, that the patches represent solid components and not merely impressions.

Also the components seen as patches on the horizontal cleavage surfaces and the thin black bands seen on the vertical sections are identical. This fact can be easily demonstrated under a dissecting microscope where a small block of coal may be split horizontally at any place with a sharp tool. It is then shown that the black bands seen in cross section are the thin flat masses seen on the horizontal cleavage surfaces.

On account of the woody structure seen on the surfaces of these thin scale-like pieces we would infer that they are derived from woody fragments or other woody plant tissues and are analogous to the woody constituents of peat. They are lenticles of anthraxylon. That this is true will be sufficiently demonstrated.

Quite often these patches are of the nature of charcoal. By most people they are called mineral charcoal, some call it mother of coal. Here in England they call it "fusain," which is merely the French for charcoal. Fusain is also derived from fragments of woody tissues, but the cause of its formation is a much debated question and little is known about it.

Impressions of the marks of the cortex of Lepidodendrons, Sigillaria and others, of leaves, petioles, and a number of other minor plant parts are frequently seen on the horizontal cleavage surfaces.

The layering of a coal may be much more clearly delineated on a polished vertical surface. Every component then stands out more sharply. Here we see more clearly the larger bands of anthraxylon. Between these are located the thinner anthraxylon bands, some of them so thin that they must be magnified in order to be seen. Between the bands we see a matter of a duller appearance, or of a greyish colour. This is a much more finely macerated

material and is derived from a large number of plant products. This is the attritus and is in every way analogous to the attritus in peat.

The distribution of the components is varied. In some layers or in some lumps of coal we may find a large number of the bands of anthraxylon; in some they may be relatively thin, in others thick, while in others again bands of all thicknesses may be jumbled together. In some layers the anthraxylon bands comprise by far the larger part, in others the attritus and the anthraxylon are present in about equal proportions, and then on the other extreme the attritus may form by far the larger part. Some coals are composed chiefly of the larger bands, others of thinner bands, other coals or parts of the seam may be composed of attritus. In English coals when layers or parts of the seam are largely composed of the woody or anthraxylon bands, the terms "brights" and "clarain" have been applied; when largely or wholly composed of attritus the terms "dulls" or "durain," and to the larger anthraxylon bands when of a homogeneous appearance and when particularly bright and vitreous in appearance the term "vitrain" is being applied. These terms can only apply to parts of coal in outward appearance and do not always apply to a specific component. Many anthraxylon bands are dull in appearance and are then not called "vitrain." Typical bands are often decidedly striated owing to an alternation of tissues or annual growth rings, and are then called "clarain." The term "clarain" cannot be applied to any definite component or entity of a coal, since a layer of coal to which this term may be applied must be composed of a mixture of thin anthraxylon bands and attritus in such a proportion to give the layer a bright silky lustre. But the compilation of anthraxylon and attritus may be in such a proportion or the attritus of such a composition or nature that it has neither the appearance of a "durain," "clarain," or a "vitrain" according to the definition.

Minute Structure of Coal.

We have now examined coal in the block from every angle from the outside, we have polished its surface and split it open and revealed the inside and have separated it into its main components. These must now be examined more closely by means of the microscope, first at a low and then at a higher magnification.

In order to examine coal by means of the microscope it must be specially prepared for it. Two methods are available: by means of thin sections, and by means of etched polished surfaces. The first is used with transmitted light, the second with reflected light or vertical illumination as used in metallography. These two methods may be used independently, but they may be used to supplement each other with increased value over each used alone. A third method consists in digesting the coal with an oxidizing agent and dissolving the partially oxidized coal with ammonia in a watch glass under the microscope and observing it as it dissolves.

THE MICRO-STRUCTURE OF COAL AT LOW MAGNIFICATION. (Fig. 1).

In any microscopic examination it is always well to study the object first under low power in order to get a better perspective of what is to be studied. t forms an essential step from the microscopic aspect of coal to its appearance under higher magnification. The finer laminations are here really brought out for the first time, and their relative sizes as well as their sizes compared with the larger components are better comprehended. It is also essential for obtaining the relationship of the woody components to the attritus as well as the relative proportions of the two. A study of the vertical section at a low magnification shows that all coals are essentially alike in their compilation. The conclusion therefore can be safely drawn that all *ordinary* Carboniferous bituminous coals are similar in structure and origin. Fig. 2 shows a part of a section magnified 30 diameters.

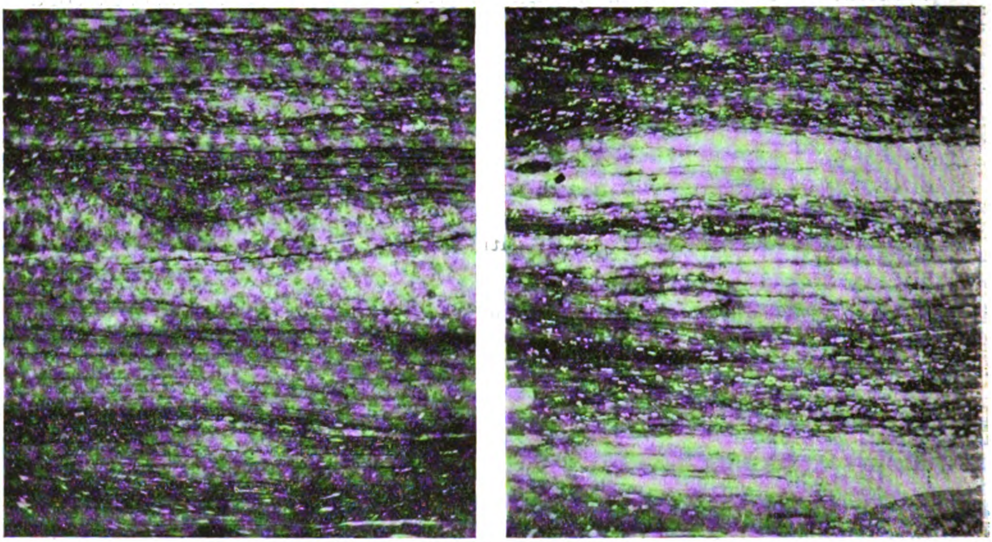
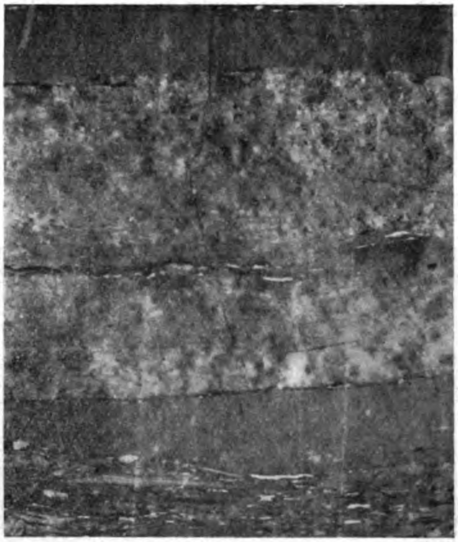


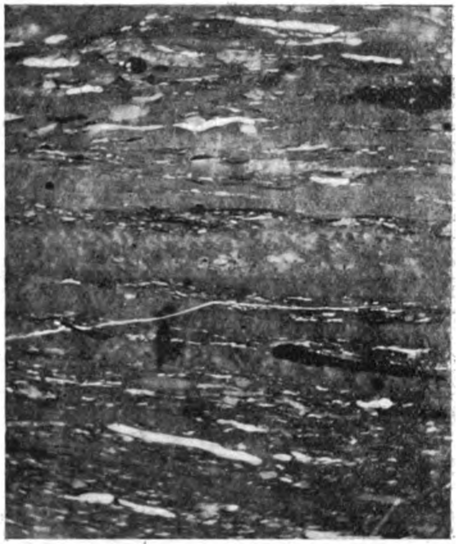
FIG. 1.—Thin sections of Beeston coal (clarain) at a low magnification showing a large number of thin bands of anthraxylon and attritus. × 20.

THE MICRO-STRUCTURE OF COAL AT HIGHER MAGNIFICATION.

We have already learned that coal is composed mainly of two kinds of components: (1) those bands derived from the woody and fibrous fragments of plants, the anthraxylon, and (2) that part of the coal derived from the more finely macerated general plant matter forming the embedding medium for the anthraxylon, the attritus. To these should be added a third component, namely that constituent resembling charcoal called mineral charcoal or fusain. The origin of these has already been shown with some evidence. Further convincing evidence is furnished in the study of the microstructure of the various components.



a



b

FIG. 2.—*a* and *b*.—Parts of Fig. 1 at a higher magnification. (*a*)shows a number of thin anthraxylon bands lying close on top of each other, but bounded by attritus above and below. × 80. (*b*) shows a number of thinner strips of anthraxylon and attritus. × 80.

THE ANTHRAXYLON.

Under the microscope the anthraxylon bands are always distinguishable from the attritus no matter how minute they may be. (Figs. 2, 5 and 7). Their boundaries are always well defined both in colour and outline. On casual observation the mass appears somewhat homogeneous whereas the surrounding attritus at once appears heterogeneous. On closer examination and particularly at higher magnifications every strip of anthraxylon no matter how small reveals some plant structure. In some pieces the structure may appear very faint while in others it appears almost as well preserved as in a sound piece of wood or cortex. Between these two lie all degrees of preservation. Woody structures are particularly brought out in horizontal sections and by polished surfaces etched with chromic acid. Recent researches based on the latter method have added much to the knowledge of the microstructure of coal.

The original tissues as a whole have been much compressed and the walls of the cells and fibres have collapsed and have been flattened (Figs. 3, 4 and 7). As a rule the cell walls have lost most of their mass, most of them remaining relatively thick. In many cases they have been reduced to a mere film, but cells are also frequently found of almost natural thickness which appear to have lost little or nothing of their original thickness. By comparing the number of cells in equal thicknesses of various anthraxylon strips and with original wood it is found that there are great variances in the degree of compression.

The amount of reduction in thickness varies from apparently but very little to a hundredth part of the original. In general the reduction is considerable. This reduction in thickness can only be accounted for by decomposition. The original arrangement of the cells with respect to one another has as a rule been much changed. Usually it appears to have been a shearing over similar to the collapse of the compartments in a cardboard egg case. Often also there is a general distortion (Fig. 3). It is not uncommon to find cell contents (Fig. 4).

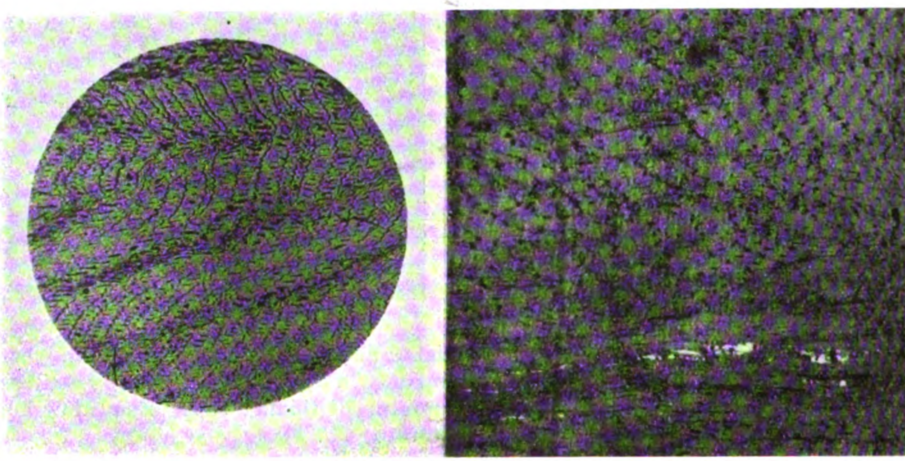


FIG. 3. (*a*.)—Woody structure of anthraxylon from a polished and etched surface. Preparation and photograph by Miss M. M. Evans. × 80. (*b*.)—Similar structure from a Pittsburgh coal. From a thin section by transmitted light. × 120.

Some of these are evidently the natural resins of the plant. These often appear to have lost little of their original bulk, quite in accord with our knowledge that the resins of the plants of to-day do not putrefy. Other cell contents are claimed by some investigators to be infiltrations. For the present the matter of the cell contents in coal structures must be left an open question.

The cell characters, such as bordered pits, spiral, trabacular, and scalariform thickenings are often well preserved. These are particularly well shown in polished and etched surfaces parallel to the bedding plane under vertical illumination as well as in thin horizontal sections.

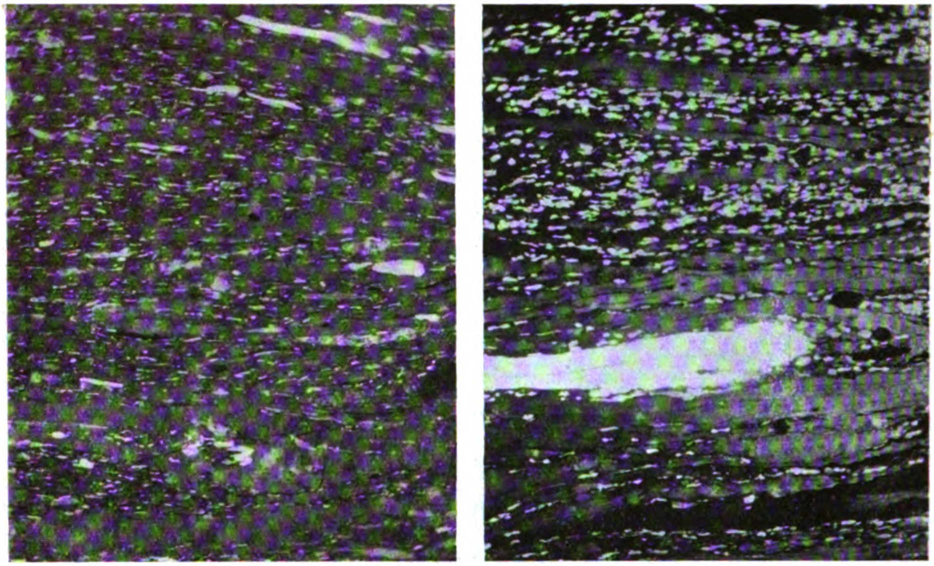
In most cases it is difficult if not impossible to determine from what particular tissue a particular lenticle of anthraxylon was derived. Both xylem and cortex may be distinguished. Which of these is the more prevalent is a controversial question. Claims have been made that the xylem is more frequently distinguishable; others that the cortex is more often represented than the xylem.*

*M. M. Evans, The Microstructure of Vitrain. Staff Lecture; Safety in Mines Research Board, University of Sheffield, Jan. 11, 1926.

Fig. 4.—Thin section of anthraxylon from the Pittsburgh bed. The structure has been much compressed. Resinous cell contents as well as ray cells are clearly shown. × 160.

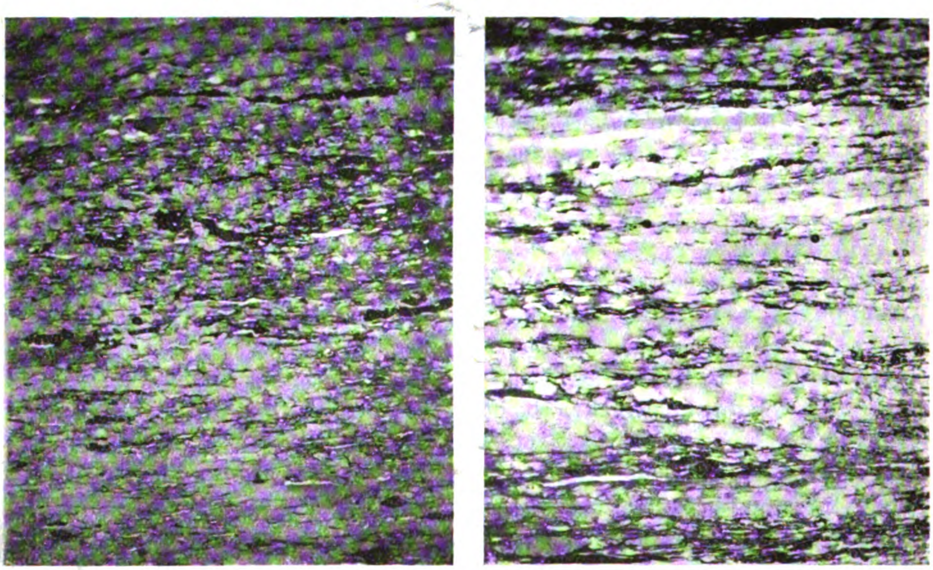
The Attritus.

The attritus is the general rubbish pile of the residue of a large number of plant organs, plant parts, and plant compounds. One would expect, therefore, to find it a very heterogeneous mass. As seen under the microscope in different parts of the section it is so varied that it defies a general description. In looking over a section from one end to the other it resembles a veritable kaleidoscope. Under a lower magnification the attritus appears as a striated to smooth granular mass. Under higher magnification it is resolved into a number of constituents, the more important of which are woody degradation matter, other carbohydrate or general humic degradation matter as bark, cortex, cork, leaf parenchyma, and spore and pollen matter, resinous and cuticular matter. These components may form the attritus in all possible proportions. The most common constituents are woody and general plant degradation matter (Figs. 5 and 6), spores



a *b*

FIG. 5.—(*a*) Thin section of the Beeston coal "clarain" from the same section as shown in Fig. 1. An attritus composed of woody degradation matter with some spore matter, including a number of anthraxylon strips. × 80. (*b*) Thin section of the Beeston coal "clarain" from the same section as shown in Fig. 1, showing a number of thin anthraxylon bands separated by an attritus rich in spore matter, also including part of a megaspore. × 80.



a *b*

FIG. 6.—*a* and *b* from the Beeston bed, from the same section as Fig. 1. (*a*) Thin section of attritus composed of humic degradation matter, including relatively few spores and some carbonized matter. × 80. (*b*) Thin section of attritus composed of woody degradation matter, including a few thin strips of anthraxylon. × 80.

(Figs. 5b), and what appear to be resinous particles, and the one or the other of these forms the predominating constituent.

The commonest occurrence of the attritus is in thin layers between anthraxylon bands (Figs. 5a, 7 and 8). Occasionally the attritus forms thicker bands and at times layers of considerable thickness in which case the layer has a smooth homogeneous outer appearance and is called cannel coal irrespective of the kind of constituent composing it (Fig. 9a and b).

SPORES.

The spores are the most conspicuous constituents of the attritus because of their transparency and bright golden yellow colour. No attritus is entirely free of spores. Two kinds are quickly recognized: microspores, found in by far the larger numbers, and megaspores (Fig. 5b). The former measures

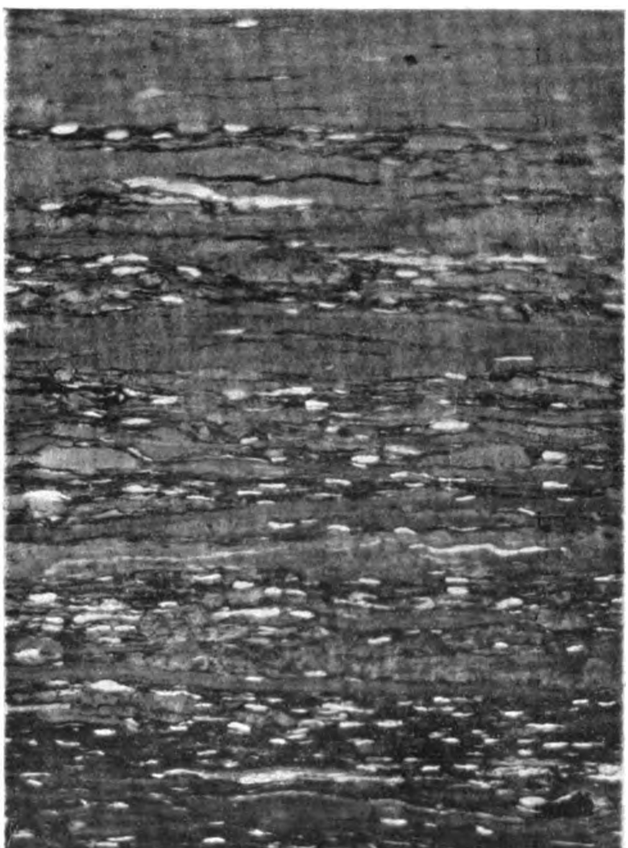


FIG. 7.—Thin section of coal from the Kittanning bed, Ohio, U.S.A., composed of attritus, enclosing thin strips of anthraxylon. The attritus is composed mainly of woody degradation matter, spores, and resinous matter. × 160.

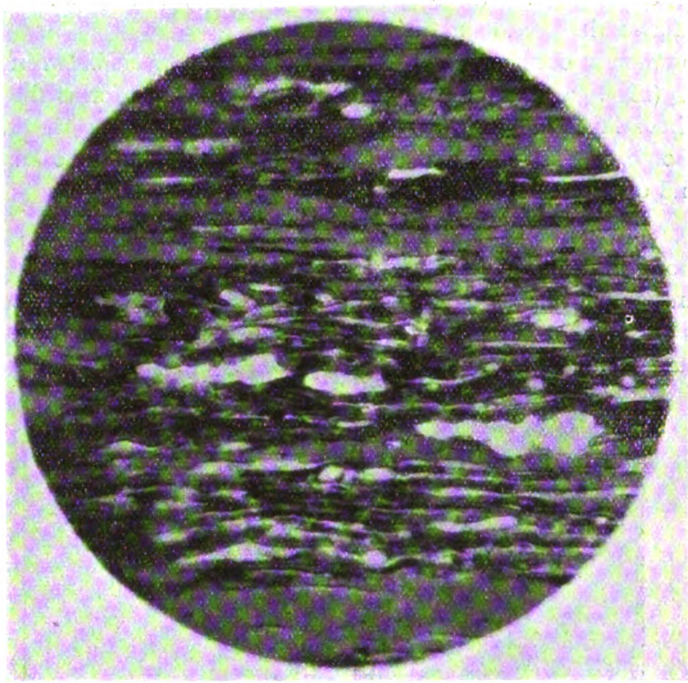


FIG. 8.—Thin section of coal from the Upper Freeport bed of Pennsylvania, U.S.A., showing the composition of the attritus at a very high magnification. × 800

approximately between 15 and 70 microns and the latter between 500 and 3,000 microns. Relatively few sizes are found between these two so that there is really a wide gap between them. The spores are represented merely by their outer shells or exines, the cell contents having long since disappeared. It is hardly fair, therefore, to call them spores, as they are in truth only spore exines. The spore exines are among the most resistant substances to decay, and to this resistance they owe their preservation. In life they were more or less spherical, but here the exines have completely collapsed and now form circular discs. They are often adorned with remarkable sculpturings, processes, hairs, tufts, and wings. These characters have usually also been well preserved and form marks for distinguishing between different species. The attritus is frequently composed largely of spores and when in thicker layers becomes of the nature of a spore cannel coal. Many cannel coals are largely composed of spore matter.

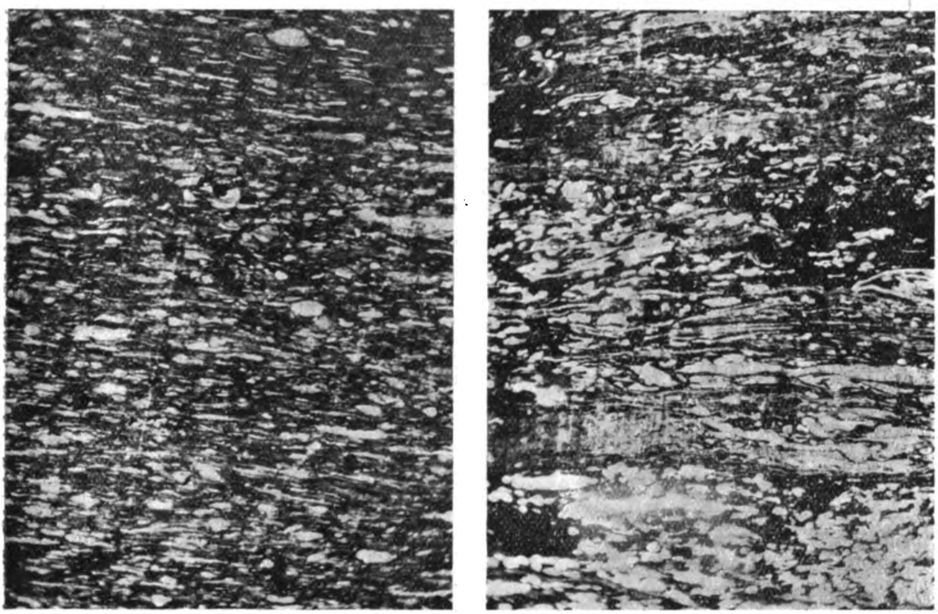
WOODY DEGRADATION MATTER. (Fig. 6).

Woody degradation matter is the most prevalent constituent of the attritus. It is so diversified in its appearance that no adequate description is possible. There is no sharp line to be drawn between the anthraxylon and the general woody degradation matter, the transition being gradual. The colour and

physical appearance is similar in both. The best idea may be had from the illustrations, but its beautiful appearance and diversified structure can only be appreciated under the microscope.

THE GENERAL HUMIC DEGRADATION MATTER.

Under this head are to be included all carbohydrate derivatives as far as they can be recognized, such as bark, cork, pith, leaf tissues, and many others. It is not always easy, and probably in some cases it is impossible to distinguish them from ordinary woody degradation matter, but in many cases distinction can be made. In peat and in lignite they are easily distinguishable. When thicker layers or larger parts of a coal seam or even a whole seam is largely composed of a general woody and humic degradation matter it partakes of the appearance of a cannel coal. The Parkgate Cannel coal (Fig. 9a) is composed of a general humic degradation matter together with some spore and resin matter.



a b

FIG. 9.— (*a*) Thin section of cannel coal from the Parkgate seam. This is an attritus composed essentially of humic degradation matter, spores and resinous matter. × 80, (*b*) Thin section of Barnsley dulls, "durain." An attritus composed of very thin anthraxylon strips, woody degradation matter, spores, and carbonized matter. The humic and woody matters are slightly more highly carbonized than in the Beeston coal. × 80.

CUTICULAR MATTER.

Like the spores, the cuticles are conspicuous constituents and are in general of the same bright yellow colour. When more highly fragmented the cuticular

and spore matters are difficult to distinguish. In larger fragments, cuticles are easily recognized as such. In thin sections they appear as golden yellow bands varying considerably in thickness. They often go in pairs, and commonly have one edge serrated. When separated out of the coal they appear as tissues with definite cell structures. Cuticles are, however, continuous membranes and the apparent cell structure is due to thickenings caused by the once underlying hypodermal cells. All coals contain more or less cuticular matter.

RESINOUS MATTER.

The attritus of all coals may contain certain oval to spherical particles that bear great resemblance to certain inclusions found in the remaining woody tissues. There are reasons to believe that they are the remainders of certain natural resins of the coal-forming vegetation.

It is quite easy, furthermore, to trace the resinous particles from peat into brown coal, lignite, sub-bituminous coals, and finally into bituminous coal and their appearance is always similar. By analogy there is, therefore, also reason to believe that they are the residues of natural resins.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said that Dr. Thiessen, with his characteristic modesty, had referred to his paper as a "picture show." In this particular "picture show" he thought they must admire the amount of labour, energy and knowledge which had been brought to bear on the subject on which Dr. Thiessen had been working for so many years. Those who had attempted to deal with these questions as chemists must, after what they had seen demonstrated by Dr. Thiessen, feel that their efforts were very futile, because when they realised the constitution of a coal seam, how the original individual units were brought together and decomposed in the peat bog, only those investigators who possessed great courage could persist in their study of so difficult a subject. The author had avoided controversial subjects; if he could prove the composition of coal, as he had attempted to do, by ocular demonstration, then there was nothing more to be said. People in this country were not familiar with Dr. Thiessen's nomenclature; he had coined the word "attritus" to represent what we knew as "durain," and the word "anthraxylon" as covering practically the combination of clarain and fusain; he laid great stress on the fact that anthraxylon was derived from wood or woody fibre. The nature of the actual decay of the original substance, whether woody or other vegetable substance, was, of course, of immense importance, and it was interesting to notice that research in quite different directions might have a bearing on the elucidation of some of these problems. Quite recently an investigator from the examination of some remnants secured from Tutankamen's tomb had been able to throw light on the chemical decay, as distinct from the bacteriological or biological decay, of vegetable substance, and on the formation of two distinct kinds of lignin derivatives.

SIR EDWARD TROUP, K.C.B., K.C.V.O., Chairman of the Safety in Mines Research Board, said he had listened with very great interest to what the lecturer had told them; it seemed to him that the investigations which Dr. Thiessen was carrying on

might lead ultimately to practical results of great importance to the mining industry. Some results with a view to safety in mines might be obtained by more direct methods but he thought by the study of the fundamental character of coal, from the chemical, physical and biological sides, possibly even more important results might ultimately be obtained.

Dr. W. R. Ormandy said the portion of the very interesting lecture which appealed to him most was the close association which was drawn between the possible constituents of the raw material from which coal had been made and the various parts of coal as they might be separated. Those who had tried to obtain samples of crude oil from various sources would know how difficult it was; if guaranteed samples of the various constituents of coal could be obtained, those who desired to experiment with the individual ingredients would be immensely pleased. It was interesting to know that in many directions in which experimental work was being done on the decomposition of coal, such as the behaviour of the constituents under the influence of heat, hydrogen and very high pressures, the various constituents were giving very different results. Durain was supposed to be the product of the breakdown of the finer portions; the attritus would not take up hydrogen and would not be converted into oil under almost any conditions which could be obtained. The more directly the constituents were produced from the woody substance, the more readily they took up hydrogen and the more readily were they converted into oil. No doubt by an extension of the interesting work which Dr. Thiessen was doing it would become possible by microscopical examination to say what relationship between the products would be obtained by the heat treatment of coal under a given set of conditions. That would lead to a very great simplification of the work of the chemist. They had to admit that to-day the chemist was working in the dark; he put into a retort a mass but had not the remotest idea what would come out.

Mr. John Roberts said he was very glad the lecturer had dispelled the illusion that age was the chief factor in determining whether coal was bituminous or anthracite. They used to be taught that anthracite was the oldest form of fossil fuel, but that was not true; anthracite and bituminous coals were both found in Carboniferous systems. On the other hand, in British Columbia in the Cretaceous system, which was millions of years younger than the Carboniferous, there was anthracite. Age was not the deciding factor in determining whether coal would be bituminous or anthracite; it depended on the pressure and temperature to which it had been subjected. The Russian lignites, to which Dr. Thiessen had referred, were probably those referred to by Prof. Erdmann, which were in the Lower Carboniferous system; Prof. Erdmann considered that those lignites reached a temperature of between 280° and 325° C. He (the speaker) was inclined to agree, because in a Jurassic lignite, which was a very much younger lignite, he had picked up beautiful specimens of natural charcoal, which could be shaved with a knife. In the commercial process of charring wood a temperature of between 225° and 300° C. was employed. It was therefore reasonable to assume that the conversion of this vegetable material into the lignite and natural charcoal had been brought about at a similar temperature. There were some lignites which began to yield oil at a temperature of 318° C.; therefore, they could not have been subjected to so high a temperature before.

The lecturer had raised one controversial matter when he said we did not know what temperature coal had attained. As a matter of fact, we could determine

fairly accurately what temperature anthracite had attained. He (the speaker) maintained that anthracite was a natural low-temperature fuel which had been carbonised at between 500° and 550° C.-- not 50° above or below. The evidence in favour of that assertion was this; in the first place, the dust of anthracite was black. If one took a little powder and rubbed it on a piece of white paper, one would see at once that it was black. The dust of bituminous coal, however, was brown. But if one heated the dust of coking coal to 400° C. it became black. That indicated that a temperature of at least 400° C. was required. The lustre which distinguished anthracite could be obtained by heating to 550° C., or thereabouts. When one distilled anthracite at 500° C., no volatile was obtained out of it, for the simple reason that it had already gone through that temperature range before. Anthracite gave a minimum of water constitution because the bulk of the water had been driven off from the bituminous coal when heated to 450° C. There was another factor: the electrical conductivity of anthracite. The electrical conductivity of Alpine anthracite was so high that it could not be used anywhere near electrical appliances, and it was impossible to use electrical appliances for the measurement and control of stocks in the bunkers. Now coal did not conduct electricity until it was heated above 550° C. Then there was another very important aspect of the matter: Hollings and Cobb had pointed out that an ordinary coal was exothermic when subjected to a temperature of between 450° and 500° C.; but if that coal were heated to 500° C., allowed to cool, and then tested, naturally it was no longer exothermic. If one heated anthracite, it was found not to be exothermic below 500° C, but it was exothermic at a temperature above 500° C, in the same way as an ordinary coal which had never been subjected to that temperature before. If, as he said, a temperature of 500° C. was required to produce anthracite, then it followed that if a mine caught fire, and was sealed off, when that mine was re-opened one would find that the bituminous coal had been converted into anthracite. That was exactly what had happened; a mine fire had occurred in 1889 at the West Leigh Collieries in Lancashire; the fire had raged so fiercely that it was impossible to deal with it, it had been sealed up and the air blocked off as far as possible. An attempt had been made from 1914 to 1916 to re-open that mine; the mine was found to be too hot to be opened, as it was still burning, and eventually it had to be abandoned. But it was found that where the coal had not been burnt to ash, it had become anthracite: instead of having a volatile of 44%, it had a volatile in the region of 17 to 19%. It had been determined that the temperature it had attained was at least 480° C.

MR. HARALD NIELSEN said he understood the Lecturer to say that he considered that most of the coals in the world were more or less alike. That opinion was certainly borne out by the fact that oils obtained from coals from different parts of this country were found to be of identical composition provided the oils were obtained in an "uncracked state," as by the L. and N. method of distillation.

A vote of thanks to the Author for his interesting Paper was carried unanimously, and the meeting terminated.

DR. A. C. THAYSEN, of the Bacteriological Laboratory, Royal Naval Cordite Factory, Holton Heath, Wareham, Dorset, writes:—

I am writing to convey to you and your Society my sincere thanks for the most interesting evening I spent listening to Dr. Thiessen's account of the microstructure of coal.

In some of our work at this laboratory we have had an opportunity of approaching the question of coal formation. This has made me appreciate the importance of Dr. Thiessen's work, especially the lead he has given to view the difficult problem of coal from a broader point of view than that frequently adopted by research workers.

CORRESPONDENCE.

DOMESTIC HEATING.

I have read with great interest the paper by Dr. Margaret Fishenden and the discussion. One of the questions to which great attention was given was that of smoke from domestic fires, and it would appear that smoke can only be prevented by burning coke of a kind which is not yet on the market at a price to compete with coal, or else gas coke, which requires specially constructed fire grates, and of which the supply would be insufficient if it were generally adopted. There is, however, another method of purifying the atmosphere which is never mentioned.

It is now a good many years since the owner of a steam boiler at a Hampshire saw mill and Messrs. Manning and Wardle, engineers of Leeds, each fitted a steam boiler with an apparatus for washing the smoke, by which they delivered into the air gases free from soot and dust. It would be quite possible to apply this method to dwelling houses, but, of course, it would require a considerable outlay of capital. I think the area under the government of the London County Council and the City of London could be fitted up with smoke washers at a cost not exceeding £50,000, 00. The annual cost of working could be under £1,000,000, making a total cost, including interest and redemption of capital 3 to 3½ million pounds a year.

This would effect a great saving in washing and repairs probably equal to the cost.

When I lived in Leeds I estimated that the saving would be equal to a rate of 6/- in the £, and the expense would be equal to a rate of 2/- in the £, but in London rateable values are much higher.

With regard to the probable future use of coke for domestic fires, it should be borne in mind that most of the English coals are not coking coals. Gas and electricity are, and always will be, too costly for poor people, and therefore the only way of keeping the air clean is to wash the smoke.

ARNOLD LUPTON.

NOTES ON BOOKS.

THE ENGINEER AND THE PREVENTION OF MALARIA. By Henry Home, M.Inst.C.E. London: Chapman and Hall, Ltd. 13*s*. 6*d*. net.

The first attempt to construct the Panama Canal was foiled by the anopheles mosquito, and it is estimated that the French Company lost 22,000 men in their disastrous failure. It was not until Sir Ronald Ross had traced the whole life-history of the malaria parasite that this great work became possible. Methods for dealing with the mosquito are now based on scientific knowledge, but, as Mr. Home remarks, the engineer working in the tropics is generally isolated from his fellow-workers and out of touch with the literature which contains the results of modern research and its practical applications in sanitary work. For a man so

situated this book should prove a godsend, for it explains in clear and simple language the various courses which he may adopt to protect himself and his fellow-workers from their least but greatest enemy.

It is pretty generally known that the anopheles mosquito, as a rule, lays its eggs in stagnant or almost stagnant water. An infinitesimally thin film of oil on the surface of the water is sufficient to asphyxiate the larvæ. Often, of course, it is possible by suitable systems of drainage to dry up the breeding grounds, and when schemes of this kind are contemplated, it is the engineer's duty to provide maps of the area to be dealt with. Mr. Home recommends that, where possible, photographs taken by air survey should be supplied. We knew that fresh uses were constantly being found for aerial photography, but this is the first time that we have heard of its being employed in the campaign against mosquitos.

The question of the cost of anti-malarial safeguards must obviously be carefully considered in any undertaking in a district where malaria is likely to be prevalent, and, of course, no general rule can be laid down here: each case must be considered separately. A simple and inexpensive method of oiling stagnant pools may be sufficient, or, on the other hand, the only possible plan may be to construct drainage works on such a scale that the proposed undertaking can never bear the cost. It is interesting to note that the Panama Canal anti-malarial works are said to have cost 5½ per cent. of the total cost of construction. This in itself was a good round sum, but when it is remembered that without this expenditure the canal could not have been constructed, the amount does not appear to be unreasonable.

In addition to his own work Mr. Home prints appendices by well-known authorities on mosquito netting, applied entomology, house flies, and water. These add considerably to the value of the volume, and should enable the lone worker in tropical countries to face and conquer his enemy, the mosquito.

THE COFFEE INDUSTRY OF HAITI.

The primary importance of coffee in the economic life of Haiti is strikingly illustrated by the trade statistics for the fiscal year ended 30th September, 1924, which show that 74 per cent. of the export trade of the Republic represents shipments of coffee.

The Haitian coffee crop is distributed throughout the mountain districts of the Republic, but the largest part is produced at altitudes of 500 to 2,500 feet above sea level. Judging from port statistics, about 70 per cent. of the coffee is grown in the south, about 10 per cent. in the central section, and about 20 per cent. in the north.

The outstanding characteristic of coffee production in Haiti, writes the United States Trade Commissioner at Port-au-Prince, is undoubtedly the limited area of the producing units. Practically the entire crop is grown on farms of less than 10 acres, by peasant farmers without capital or knowledge of cultivation methods. In the days of the French régime there were several thousand sizable coffee plantations in the colony, but after the evacuation these estates were split into numerous small farms, and the remnants of the old colonial plantation system compose to-day the principal coffee-producing areas.

Inasmuch as the crop is produced on small farms, it is impossible to estimate production and area planted to coffee. Export figures are the only guide to production, and an inspection of these reveals the fact that during the eight years of American occupation, viz., from 1916-17 to 1923-24, Haitian coffee exports averaged about 63,597,405 lb. During the year ended September 30, 1924, 64,871,045.

pounds of coffee were shipped out of the country, a decline of some 14,000,000 pounds from the 1922-23 total. Approximately 80 per cent. of the total exportation goes to France, and about 90 per cent. to Europe as a whole.

The peasant farmers have done little in the way of weeding, pruning, or cultivating, though some planting and transplanting has been attempted. Most of the coffee comes from plants that have grown voluntarily from seeds scattered by the parent trees. As a result, the trees are frequently too close together and too heavily shaded. Systematic cultivation, with transplanting from seed beds and nurseries to previously prepared land, is practically unknown. The trees bear for 20 to 25 years ordinarily, but some Haitian trees are said still to be producing 50 to 60 years after having been planted.

The Haitian coffee industry has ample room for expansion. Large areas of lands with good soil, suitable temperature, and copious rainfall are still available for plantations, but care must be taken in the matter of titles. Without planting any new acreage production could be greatly increased, and probably doubled by using scientific methods of cultivation.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 p.m. :—

April 28.—James Paterson, M.C. (of Messrs. Carter, Paterson and Co., Ltd.), "Horse Traction and Motor Traction." Sir Henry P. Maybury, K.C.M.G., C.B., M.Inst.C.E., Director-General of Roads, Ministry of Transport, in the Chair.

May 5.—C. F. Elwell, B.A., M.I.E.E., F.Inst.Rad. Engrs., "Radio: Its Past, Present and Future." Professor William Henry Eccles, D.Sc., F.R.S., in the Chair.

May 12.—Warre Bradley, "Industrial Welfare in Practice." Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., in the Chair.

Special Meeting.

Thursday, May 6, at 4.30 p.m.—Sir Frank Baines, C.V.O., C.B.E., Director of Works, H.M. Office of Works, "The Preservation of Ancient Cottages." Sir Charles C. Wakefield Bt., C.B.E., in the Chair.

Indian Section.

Friday, May 7, at 4.30 p.m.—Herbert Baker, A.R.A., F.R.I.B.A., "The New Delhi." The Right Hon. Lord Hardinge of Penshurst, K.G., G.C.B., G.C.S.I., G.C.M.G., G.C.I.E., K.C.V.O., in the Chair. The lecture will be illustrated by lantern slides.

Monday, May 31st, at 4.30 p.m.—Lieut.-Col. Sir Arnold Talbot Wilson, K.C.I.E., C.M.G., C.S.I., D.S.O., of the Anglo-Persian Oil Company, Ltd., "The Military Record and Potentialities of the Persian Empire." The lecture will be illustrated by a Film showing the daily life of one of the warlike races of Persia. Brigadier-General Sir Percy M. Sykes, K.C.I.E., C.B., C.M.G., in the Chair.

Friday, June 11th, at 4.30 p.m.—Capt. B. K. Featherstone, "Travels in the Kara-koram Himalayas." Sir Francis E. Younghusband, K.C.S.I., K.C.I.E., LL.D., D.Sc., in the Chair. The lecture will be illustrated by lantern slides.

Dominions and Colonies Section.

Tuesday, May 4, at 4.30 p.m.—Charles Ponsonby, Managing Director, British Central Africa Company, "Nyasaland." Brigadier-General Sir S. H. Wilson, K.C.M.G., K.B.E., C.B., Permanent Under-Secretary of State for the Colonies, in the Chair.

Cantor Lectures.

Charles Reed Peers, C.B.E., M.A., Director, S.A., Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." Three Lectures April 19, 26, and May 3.

Lecture II.—Roman Britain. The northern invaders. The Christian Mission. Iona and Northumbria. Benedict Biscop and Wilfrid. Offa of Mercia. Alcuin and Charlemagne. The classic revival. The Danes. The Norsemen. Alfred. Athewold and the School of Winchester.

Lecture III.—Edward the Confessor, and the Normans. The Norman Conquest. English Romanesque. The evolution of Gothic art and its use of ornament. The high-water mark. The decline.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

Monday, April 26..Actuaries Institute of, Staple Inn Hall, Holborn, W.C. 5 p.m. Mr. R. C. Simmonds, "Notes concerning some practical points that arise in the Valuation of Widows' Funds."

Electrical Engineers, Institution of, at the Armstrong College, Newcastle-on-Tyne. 7 p.m. Annual General Meeting. Mr. B. A. Robinson, "Modern Methods of Measurement."

At the University, Birmingham. 7 p.m.

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Mr. C. F. Rey, "A recent journey to Gudru and Gojam (Abyssinia)."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Rev. Dr. H. U. Weitbrecht Stanton, "The Qur'an and its Doctrine of God."

Tuesday, April 27..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. C. Barrington Brown, "Stone Implements from North-West Peru."

Asiatic Society, at the Royal Society of Arts, Adelphi, W.C. 8.30 p.m. Mr. Sidney Smith, "The Cylinder Seals of Western Asia."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. "Refrigeration."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Annual General Meeting.

Photographic Society, 35, Russell Square, W.C. 7 p.m. Mr. W. Vinten, "International Standardization of Kinematograph Standards."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Barcroft, "Feathers."

Zoological Society, Regents Park, N.W. 5.30 p.m. Scientific Business Meeting.

Wednesday, April 28..Automobile Engineers, at the College of Technology, Manchester. 7.30 p.m. Mr. G. Rushton, "Omnibus Repair."

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. Mr. J. H. G. Monypenny, "Some Micro-Structural Features of Modern Rustless Steels." Mr. Harold Wrighton, Demonstration of the preparation of Metallic Micro-Specimens. Messrs. R. & J. Beck, Exhibition of Swan Photo-micrographic Apparatus and Radial Metallurgical Microscope.

Thursday, April 29..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Aeronautical Society, 7, Albemarle Street, W. 6.30 p.m. Lieut.-Col. V. C. Richmond, "The Results of Recent Airship Flight Tests."

Child-Study Society, at 90, Buckingham Palace Road, S.W. 5.30 p.m. Annual Meeting. Mr. Alexander Farquharson, "Homeland Survey for Children."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. Messrs. B. S. Cohen, A. J. Aldridge and W. West, "The Frequency Characteristics of Telephone Systems and Audio-Frequency Apparatus and their Measurement.
At University College, Dundee. 7.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir W. Bragg, "The Imperfect Crystallisation of Common Things."

Royal Society, Burlington House, W. 4.30 p.m.

Illuminating Engineering Society, at the Royal Society of Arts, Adelphi, W.C. 7 p.m. Dr. James Kerr, "School Lighting (Modern Requirements and Recent Progress)."

Chemical Society, Burlington House, W. 6 p.m. Prof. Dr. W. E. S. Turner, "Additive Relationships in the Properties of Glasses."

Friday, April 30..Junior Institution of Engineers, at the Royal United Service Institution, Whitehall, S.W. 7.30 p.m. Air Vice-Marshal Sir W. Sefton Brancker, "Air Transport."

Mechanical Engineers, Institution of, Storey's Gate, St. James's Park, S.W. 7 p.m. Mr. C. W. J. Taffs, "Marine Oil-Engines in Practice."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Dr. W. H. Eccles, "Wireless in the Empire."

Transport, Institute of, at Lime Street Station Hotel, Liverpool. 6.30 p.m.

Saturday, May 1..Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. P. C. Buck, "Song Form in England (1) Stanford." 5 p.m. Annual Meeting.

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FRIDAY, APRIL 30th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, MAY 3RD at 8 p.m. (Cantor Lecture.) CHARLES REED PEERS, C.B.E., M.A., Director, Society of Antiquaries, Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." (Lecture III.)

TUESDAY, MAY 4TH, at 4.30 p.m. (Dominions and Colonies Section.) CHARLES PONSONBY, Managing Director, British Central Africa Company, "Nyasaland." BRIGADIER-GENERAL SIR S. H. WILSON, K.C.M.G., K.B.E., C.B., Permanent Under-Secretary of State for the Colonies, will preside.

Tea will be served in the Library from 4 p.m.

WEDNESDAY, MAY 5TH, at 8 p.m. (Ordinary Meeting.) C. F. ELWELL, B.A., M.I.E.E., F.Inst.Rad.Engrs., "Radio: Its Past, Present and Future." PROFESSOR WILLIAM HENRY ECCLES, D.Sc., F.R.S., will preside.

THURSDAY, MAY 6TH, at 4.30 p.m. (Special Meeting.) SIR FRANK BAINES, C.V.O., C.B.E., Director of Works, H.M. Office of Works, "The Preservation of Ancient Cottages." SIR CHARLES C. WAKEFIELD, BT., C.B.E., will preside. The lecture will be illustrated by lantern slides.

Tea will be served in the Library from 4 p.m.

FRIDAY, MAY 7TH, at 4.30 p.m. (Indian Section.) HERBERT BAKER, A.R.A., F.R.I.B.A., "The New Delhi." THE RIGHT HON. LORD HARDINGE OF PENSHURST, K.G., G.C.B., G.C.S.I., G.C.M.G., G.C.I.E., K.C.V.O., will preside. The Lecture will be illustrated by lantern slides.

Tea will be served in the Library from 4 p.m.

SIXTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 21ST, 1926. THE RIGHT HON. VISCOUNT CHELMSFORD, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., in the Chair.

The following candidates were proposed for election as Fellows of the Society :—

Aiken, Frank Jay, New Orleans, U.S.A.
Fishenden, Mrs. Margaret, D.Sc., London.
Hendrie, George A., Niagara Falls, New York, U.S.A.
Maggs, Miss Lucy Agnes, Bath.
Weigall, Lieut.-Colonel Sir Archibald, K.C.M.G., London.

The following candidates were duly elected Fellows of the Society :—

Chettiar, M. K. P. M. Chidambaram, Ramachendrapuram, Pudukotah State, India.
Dunsmore, Major R. L., B.A.Sc., Talara, Peru, South America.
Hakim, R. S. Dewan Rattan Chand, Quetta, Baluchistan, India.
Thompson, Fred, Keighley, Yorks.

A paper on "Some Aspects of the Business Side of an Army," was read by LIEUTENANT-GENERAL SIR GEORGE MACMUNN, K.C.B., K.C.S.I., D.S.O.

The paper and discussion will be published in the *Journal* dated May 28th.

CANTOR LECTURE.

MONDAY, APRIL 26TH, 1926. MR. CHARLES REED PEERS, C.B.E., M.A., Director of the Society of Antiquaries, Chief Inspector of Ancient Monuments, H.M. Office of Works, delivered the second of his course of three lectures on "Ornament in Britain."

The Lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

FOURTEENTH ORDINARY MEETING.

WEDNESDAY, 17TH MARCH, 1926.

SIR RICHARD A. S. REDMAYNE, K.C.B., Past President, Institute of Mining and Metallurgy, Chairman of the Advisory Council on Minerals to the Imperial Institute, in the Chair.

The paper read was :—

CO-PARTNERSHIP.

By COLONEL J. H. BORASTON, C.B., O.B.E.

I should not have ventured to accept the invitation which you have so kindly extended to me to speak on this subject to-night, were it not for two things. First, that I have been for some years past personally connected with one of the earliest and most successful examples of a scheme of full co-partnership in working in this country. Second, that I have so much faith in the

principles of Co-partnership, and am so conscious of the unique opportunity which exists to-day for their wider adoption, that I felt that it were better that their exposition should be attempted even by so poor an advocate as myself than that an occasion like this should be lost.

That is my apology for my own presence at this desk; for my subject I make no apology at all. Any proposal which has for its object the establishment of permanently improved relations between employer and employed, between capital and labour, is worthy of attention in this year of grace. A policy in support of which its advocates can point to numerous practical examples in actual successful working should surely command the most earnest and careful consideration of all thoughtful men and women.

Co-partnership is such a policy. It is a serious proposal, based on general principles which, if one may judge from the public utterances of men of all parties, are already widely accepted. It is, moreover, a practical proposal; for after nearly a century of experiment it can show to-day a substantial number of instances of successful application over a comprehensive range of businesses.

It has been said, and said rightly, that Co-partnership is essentially a principle, and not a scheme. That is one of the secrets of its present successes and the greatest hope for its wider application. The principle can be given effect to in a variety of ways, more or less complete; so that there may be large variations in the detail of the schemes embodying it to suit the varying needs and conditions of different types of industry.

The first principle of Co-partnership is as old as human nature. It is that the normal average man will work harder and better for himself than he will for any master. It was expressed in another connection but in a telling phrase by Arthur Young, when he wrote that it is the magic of property which turns sand into gold. Give a man a sense of proprietorship, of part-ownership, in the business in which his days are spent, and he will view his working hours in quite a different spirit than that crystallised in the phrase that he has no intention of sweating himself to make the boss a millionaire.

The second principle is that the giving to the worker of a substantial share in the ownership of the business in which he is engaged need not and should not depreciate the value of the shares which are left to those who provide the capital and direction of the business. Rather, the result should be the opposite. There should be an all-round gain in which capital should have its share as well as labour. "Do unto others as ye would that they should do unto you" is good business as well as good christianity.

Therein lies the economic justification of Co-partnership. It is a common complaint that industry is looked upon to-day too exclusively as a business proposition; as an affair of dividends, and not as a human concern in which the well-being and happiness of all engaged in it are the constant thought of those who have control. There is much to be said for that criticism;

though perhaps less in these days of welfare work, industrial insurance and industrial psychology than at any other period since the industrial revolution. But I for one should have nothing to say for Co-partnership, in any of its forms, did I not believe with conviction that it is economically sound.

British industry is already far too heavily handicapped in a hundred-and-one directions to bear the burden of any new scheme which, whatever advantages it may hold out to one section of those engaged in industry, is not actively creative of economic wealth. It has been laid down by an authority greater than mine that if an advantage in the distribution of the national dividend is pushed too far, it may re-act on the production by injuring the efficiency of some one or more of the parties engaged as agents in that process. We have not got far to look for examples of that. The experience of America has proved that high wages are compatible with high industrial efficiency and enormous output. We have our own experience in the Coal Trade, to go no farther, to show how an industry can be crippled by labour demanding from it a higher return, having regard to the services given, than the industry can stand.

The third basic principle is that there are three necessary factors in every form of human endeavour, capital, management, and labour; and that the three are allies, not by the will of man, but by a law of nature. Man has often enough rebelled against the law; but ever to his own misfortune. No business, no industry and no nation can thrive on the basis of a constant struggle and the use of force—strike or lock-out—between partners who are indispensable to one another. A house divided against itself cannot stand. A nation which spends its working days in industrial wranglings must, other things being approximately equal, go down ultimately before another which has the moral strength, patriotism and intelligence to combine the three essential factors in common and sustained effort.

Those are the basic principles. How does Co-partnership apply them? There are a number of subordinate principles, principles of application, which will be found working in greater or less degree in successful Co-partnership schemes.

First, the employee must be given a reward outside and in addition to the standard rate of wages in his trade. That is the initial stage towards the acquisition of an interest in the business itself, the first step towards part-ownership. Many schemes of Co-partnership get no further, or little further, than that. They belong to the great group of profit-sharing concerns, of which Messrs. Clarke Nickolls & Coombs, Ltd., is, perhaps, an outstanding example. Incidentally, it should be noted that an essential preliminary to a scheme of this kind is the existence of something which can be pointed to as a standard rate of wages for the trade. That is, indeed, an essential to every form of Co-partnership. It is the answer, and I venture to suggest the complete answer, to the criticism that Co-partnership is antagonistic to

Trade Unionism. Trade Unions perform an essential function as the principal active agent, on the Labour side, in the determining of fair standard rates of wages. The existence of some such organised body, capable of performing that function, is a *sine qua non* of Co-partnership.

The interest of the worker in the business is, however, but slight, and likely to be ephemeral, if it is confined to the receipt of a profit-sharing cash bonus. All that is really requisite for a scheme of that kind is the existence of profits, and such a scheme rarely survives a period of bad trade in which profits disappear. It does nothing to effect any permanent improvement in the lot of the worker. It offers no inducement to thrift. The bonus is probably spent as soon as it is received, and it is not easily differentiated in the mind of the worker from his ordinary cash wages. He is given no opportunity to understand the basis of the scheme, namely that the bonus has to be earned before it can be distributed. His interest in the scheme, and any greater enthusiasm in his work, which the launching of the scheme may have engendered, flag together. The bonus becomes a dead weight upon the business in its competition with non-profit-sharing rivals.

To get better results, it is necessary to carry the scheme a step further and to provide that some part of the bonus shall be paid, not in cash, but in some form of claim upon the business and its assets. The best form is that a proportion of the bonus, usually one-half, shall be distributed in the form of ordinary shares in the business itself, ranking *pari passu* for capital aud dividend with the ordinary shares issued to the public, and carrying the like rights. Where, however, there are no shares issued to the public, or for any reason it is thought that the issue of ordinary shares is undesirable or impracticable— it might in some cases lead to over-loading the business—a common device is to issue some form of special bonus share or certificate, carrying interest but no voting right and marketable only with the Company itself. Examples of this latter kind of scheme are Lever Bros. and Messrs. J. T. and J. Taylor, Ltd., woollen manufacturers of Batley. Some arrangement has usually to be made for the accumulation of the bonuses in the hands of trustees until the individual holding is sufficient to purchase a share.

This second principle of application has much to recommend it and many schemes go little further. It does give the worker a definite, increasing and, so long at least as he remains with the company or firm, a permanent interest in its prosperity. It is a direct incentive to thrift and has a noteworthy effect in raising the general standard of the employees. Their self-respect grows with their share-holding and they begin to form a truer appreciation of the part played by capital in industry and a higher regard for its interests. As the employees gradually acquire a larger holding in shares or certificates in the undertaking, their sense of proprietorship increases. The basic principles to which I have referred begin to have their effect. The employee feels that he is indeed working for himself, that his reward can and will be

increased by his own efforts; that the prosperity of the business is his own concern, and its misfortunes his own loss. He has a natural disinclination to jeopardise that prosperity by strikes, or to submit to its being jeopardised by the action or inaction of others.

Co-partnership would seem already to have realised its ideals, but for one thing. Under a scheme of this kind, the employee has no real opportunity of judging whether he is really getting a fair deal; whether he is receiving himself a fair share of the greater economy of production resulting from his livelier interest in the prosperity of the business, his more careful and more conscientious work. There is nothing to bridge the gap between the manual worker and the directing or supervising management.

A strong personality, a captain of industry capable of winning the respect, affection and confidence of his employees—a man like the late Sir George Livesey, to avoid quoting living examples—may overcome that suspicion; and so long as such a man is in control the system I have just described will work, and will realise very nearly the full advantages that can be looked for from Co-partnership. "For forms of government let fools contest; whate'er is best administered is best." I will not vouch for the verbal accuracy of that quotation; but the truth it expresses applies peculiarly to Co-partnership schemes. Many an indifferent or incomplete scheme has been successful because a good man has run it.

But such a scheme is dependent on the man, and is too likely to die with him. To ensure comparative permanence, to make success independent of the individual, the scheme must contain another element. It must incorporate one other of my principles of application, and one on which I personally set great store. It must be so framed as to realise the full educational value of Co-partnership.

So far, the principles applied have given the employee additional rights; they have done little directly to increase his sense of responsibility and duty; but the definition of Co-partnership adopted by the Labour Co-partnership Association, to which I fully subscribe, is as follows:—a system which gives the employee a share in the profits of the business in which he works, a share in its capital, and a share in control and responsibility. Those three elements, intentionally or unintentionally are arranged in order of historical truth. They are also, in my view, arranged in inverse order of value and importance.

In that last provision, the share in control and responsibility lies to my mind the crux and essence of the whole matter. It gives the final answer to the charge that Co-partnership is merely another and more subtle method adopted by capital to exploit the worker. It alone can give the worker that full understanding of industrial matters which must prevent, must come before, that final and whole-hearted alliance of capital, management and labour for their mutual good which is the ultimate ideal of Co-partnership.

There are a number of Co-partnership undertakings which

have gone a very considerable way towards giving full effect to this last of my principles of application. There is, first, the fact that they have opened to their employees the opportunity of becoming ordinary shareholders in the business, with the right to vote at shareholders' meetings, and with the duties and responsibilities which that right entails. Let no one suppose that the right is insignificant. Though the individual employee's holding may be small, the aggregate holding of the co-partners is often very large indeed, and I need not emphasise the importance of a solid block of shares at a shareholders' meeting

Secondly, these more advanced undertakings—and their number steadily increases—have set up Co-partnership or Works Committees, composed usually of elected representatives of the employees and of nominated representatives of the Board and management. To these committees is delegated in greater or less degree an important share in the internal management of the undertaking concerned. They bridge the gap between capital, management and labour. Their meetings give opportunities to discuss common problems, to air difficulties and grievances, to explain and understand, on the one side and the other, exactly where the shoe pinches and how best the pressure may be relieved.

These committees, by whatever name they may be called, are doing work of inestimable value, in the Co-partnership companies where they are to be found, to remove old suspicions and jealousies, and to replace them by a spirit of harmony and goodwill. Their educative value is enormous, and it is by no means wholly on one side. Masters and men, to use the old expression, have both much to learn from each other, and these Co-partnership committees are the schools where they are taught mutual understanding and mutual respect.

There is only one step more. The problem is to give labour a share of responsibility and power, while retaining discipline, efficiency and proper organisation. I venture to submit that it is a problem which can best be solved by cutting down the last barriers and, in undertakings of a size to permit of it, opening the Board of Directors to properly qualified representatives of the employees. The effect of such a step is to remove the last breath of honest suspicion of the motives of capital and management, and to bring the whole mass of employee co-partners solidly behind the Board in its efforts to promote the prosperity and efficiency of the undertaking.

Capital, management and labour meet at a common table, to discuss a common objective, and to lend their united efforts to its achievement. On the one hand, the ladder of advancement is open to the youngest employee, by which to rise by good service to the top of the tree; and his elders will tell him, if he cannot see it for himself, that it is only by good service and good discipline that he can hope to climb. On the other, the shareholders know that, come what may to the course of trade, the business into which they have

put their money will not go down if the employees in that business can help it.

I am not speaking without the book. I have discussed in broad outline the principles on and by which the successful Co-partnership schemes of this country—with many variations in detail to meet special circumstances—are founded and built up. Let me in conclusion, and in support of my general argument, describe to you very briefly the Co-partnership scheme with which I am myself connected.

I have the honour to be a Member of the Board of a Company which has enjoyed a Co-partnership scheme for more than a generation. In all that period the Company has experienced no industrial trouble of any kind. I attribute that happy circumstance largely to the fact that ours is a scheme of full co-partnership, in which two employee co-partners have seats on the Board of Directors. Nor is our experience unique, for a neighbouring and larger Company, working on a similar system with employee directors, has been equally free from industrial trouble for an even longer period.

The Co-partnership scheme of the South Suburban Gas Company, like that of its larger neighbour the South Metropolitan Gas Company, owes its existence to the energy, ability and vision of one man, Sir George Livesey. The motive which impelled that great man to take up the work which was to prove his lasting memorial was not, as in some quarters it has been misrepresented as being, the desire to defeat a strike. For a number of years before the industrial crisis in which his first scheme, that of the South Metropolitan Company, was launched in 1889, Sir George Livesey had been urging his fellow-directors of that Company to adopt a scheme of profit-sharing as a means, not of weakening the power of the Unions or lessening the risk of strikes, but of raising the standard of living among the employees of his Company and of discharging the duty which, as an employer of labour, he believed was laid upon him towards those whom he employed.

His proposals were not at first well received; but he persevered, until ultimately he won his fellow-directors round to his way of thinking and it was decided that the experiment which has brought happiness, contentment and increased prosperity to many thousands should be given a trial. It was then, after the scheme had been accepted, that the Trade Union leaders, fearing a loss of members and a weakening of their influence, called out the men against the scheme. But Sir George Livesey had faith in his scheme, and was prepared to maintain it as resolutely against the Union as he had urged it previously against the apathy and scepticism of his co-directors. It was the Union which called the fight, and it was the men, when they had learned what the scheme meant and what it held out to them, who brought the contest to an end. The scheme triumphed, and from that day to this there has been peace and good will in that Company.

It was in 1894, five years after the inception of the South Metropolitan scheme and with its experience as a guide, that our own scheme was started. Its object was the same, to improve the lot of the employees, to encourage thrift and self-respect, and to create among them gradually, but surely, a wider outlook and a better understanding of social and industrial problems. Sir George Livesey was wont to express his aim by saying that it was in the nature of gas to rise, and therefore those who made it ought to rise too.

It was an excellent motive with which to start. It appealed to that capacity for idealism which is one of the fundamentals of English character. It has proved, as has so often happened in the history of social and moral progress, that the moral motive has sound economic justification. Throughout the history of the undertaking since 1894, the objective which the co-partners of all degrees have held steadfastly before them has been of a moral, rather than an economic order. We have striven for better conditions inside and outside the works; to give every co-partner a chance to rise in the social scale and to establish an atmosphere of harmony and mutual helpfulness in every department of the business. The more nearly we have approached our ideals, the more efficient the undertaking has become and the greater has been the material prosperity of all concerned in it.

A great deal, I am not sure but that I might say everything, depends upon the spirit in which such a scheme is started. It must be acceptable to the men. It must recommend itself to them as a fair deal, honestly put forward. It follows, that they must understand it. They will expect it to offer definite advantages, not only to the employees, but to capital. If it does not, they will distrust it. A gift horse will always be looked in the mouth. That may not be polite; but it is good horse-sense.

Sir George Livesey saw to it that the scheme was thoroughly well explained to the men, and that they understood it when they accepted it. He did not scruple to tell them plainly that for the advantages given them they were expected to give something in return, in the shape of goodwill and honest work during working hours. The scheme itself was one readily intelligible to gas men. The Company was already working on a sliding scale basis. That is to say, there was a standard dividend payable on the ordinary stock and a standard price for gas. For every reduction of a penny under the standard price per 1,000 cubit feet (it was before the days of therms and we reckoned gas then in terms of cubic feet) we were allowed to increase the standard dividend by 3/4. Conversely, for every penny of increase over the standard price of gas to the consumer, the standard dividend had to be diminished by 3/4d.

We adapted that principle to our Co-partnership bonus. We fixed a standard rate of bonus on wages at $\frac{3}{4}\%$ when the price of gas was 3/1d. per thousand cubic feet and we undertook to increase the bonus by $\frac{3}{4}\%$ for every 1d. reduction in the price of gas. In 1894, the price of gas was 2/9 per

1,000 cubic feet, so the Co-partnership scheme started with a bonus at the rate of 3% on wages. Every employee whom the Company was willing to accept as a co-partner—and he was not accepted unless he was recognised to be deserving of the privilege of co-partnership—if he was willing to sign on for a definite term of service (usually 12 months, but with a minimum limit of 3 months) became entitled, when the accounts were made up and the profits of the business ascertained, to a bonus of 3% on his wages.

The scheme provides that the whole bonus when declared becomes the absolute property of the employee co-partner; but he is only entitled to one-half of it in cash. The remaining half is accumulated in the hands of trustees at 5% interest; until the amount standing to the employee's credit is sufficient to purchase £5, or some multiple of £5, worth of stock. It is then invested in ordinary stock of the Company in the name of the employee.

The object of this arrangement is to encourage thrift and the saving spirit, and to ensure, so far as possible, that every co-partner shall gradually become a capitalist himself. In order to foster this spirit, an active effort is made to encourage the co-partners to invest the whole of the bonus, and not the compulsory half only, and even to add their own private savings to the bonus and invest them too. The advantages of the system are so well understood that in the vast majority of cases the whole bonus is, in fact, regularly invested, and at times considerable additions are made out of private savings.

To provide the necessary stock for these investments, the Secretary of the Company is authorised to go into the market from time to time, as opportunity offers in the course of the year, and buy in advance, and therefore usually on favourable terms, an amount of stock which is judged to be sufficient to meet the requirements of the co-partners when the bonus comes to be declared. The Board then fixes the price at which the stock so bought is to be sold to the co-partners, namely at the average price at which the Secretary has been able to buy it in the market; with the result that the co-partners usually get their stock at something under its actual market price at the time.

This part of the system has itself an educative value. It teaches the co-partners to watch the market, and to get to know and appreciate the way in which the value of stock fluctuates. Indeed, they watch the market to some purpose. A few years ago, as you may remember, the market value of Gas Stocks generally was, for reasons connected with war conditions, very much under its true value, and as conditions became more normal the market value began to appreciate rapidly. Meanwhile, the Secretary had been buying stock; until he held, I think, some £8,000 worth which was thought sufficient to meet the bonus for the year, and the Board had fixed the price at which the stock was to be sold to the co-partners. But by the time that had been done, the stock had advanced again by several points. The co-partners put their savings together, and applied for some £13,000 worth of stock.

The system of bonus I have described is the profit-sharing side of our scheme and you will see that it realises the first two requirements of Co-partnership, namely that the employee shall obtain, in addition to the standard rate of wages for his trade, a share in the profits of the business in which he is engaged and a share in the capital of the business. In the years before the war, the efficiency of the Company as a manufacturer and seller of gas increased and the price of gas fell until, just before the war, the employee co-partners were getting a $7\frac{1}{2}\%$ bonus and the shareholders a 6% dividend.

Then there is the other and really more important side of the scheme, that which realises the third requirement of Co-partnership by giving the employee a share in responsibility and control. The first step in this direction dates from the initiation of the scheme. It took the form of a Co-partnership Committee (the Profit-sharing Committee it was first called, but that name soon ceased to be appropriate) comprised of 16 representative workmen co-partners elected by ballot by the co-partners themselves, and an equal number of members mominated by the Board of Directors.

This Committee gives both the management and the workers the opportunity to meet and exchange views, to discuss suggestions coming from either side, and enables either side to realise the special difficulties of the other and to make reasonable allowance for them. It brings the Board and Management into close touch with the workers, and helps to restore the personal element which modern industrialism has tended to destroy. As time has gone on, the sphere of activity of the Co-partnership Committee in the internal management of the Company has gradually increased. Fresh duties have been added to it, and in 1919 a new step was taken by forming the elected half of the Committee into a permanent sub-committee, known as the Works Committee, with its own secretary.

The Works Committee has proved to be a most useful concession to human nature. It is found that the employee co-partners speak their mind more freely when they are among themselves with no official present. As one of the objects of our scheme is to get the views of the employees fully, freely and honestly stated, so that fair consideration can be given to them and no grievances are nursed in secret, the Works Committee performs a most useful function. Not every complaint which is brought before the Works Committee gets any further. The men do justice among themselves, and only a case which is felt to have some merits is reported to the full meeting of the Co-partnership Committee for further consideration and adjudication. From the Co-partnership Committee there is a right of reference to the Chairman of the Company, with a final appeal to the full Board whose decision is final. Rarely indeed is it necessary to take a case so far as that; and, should a case go so far, every co-partner knows that every circumstance of it has been presented and thrashed out, and that the final decision taken is the one which the Board, knowing all the circumstances, believes to be in the best interests of the Company as a whole, the employee co-partners included.

It will be seen that the Co-partnership Committee, with its permanent sub-committee, has very real and responsible duties to perform. It attends, too, to the social side of the Company's life and deals with all matters concerning the health, comfort, convenience, and general welfare of the employees, including insurance, pensions, accident and sick fund benefit and the like. It goes a long way to assure every co-partner that he will meet with even-handed justice in his dealings with the Company and that merit will be recognised; it goes far to make him feel that he has a real voice in the affairs of the Company and a real responsibility towards his fellow co-partners, whether they are workers, management or shareholders.

The scheme, however, does not stop there. By the time that it had been in operation for ten years, the yearly investments of bonus in the Company's capital had resulted in the employee co-partners becoming the owners of a substantial block of ordinary shares, of course carrying votes at shareholders' meetings. It was felt that the extent of their holding justified the granting to them of special representation on the Board of Directors, and that such a privilege would immensely strengthen the Co-partnership scheme. In the Company's Act of 1904 provision was made for the election by the employee co-partners by ballot (one vote being enjoyed for every £10 worth of stock up to £100, another for every additional £25 worth of stock up to £300, and another for every £50 of stock held above £300) of 2 employee Directors to sit with the shareholders' Directors, take part in their deliberations, and enjoy equal powers.

The Employee Directors retire in rotation, one each year, and are eligible for re-election. Their qualification is two-fold—continuous employment with the Company for 14 years or upwards and the holding of a certain quantity of the Company's stock. There are at present, I believe, some 50 or more employee co-partners who possess both these qualifications.

We do not pretend that the system I have sketched out to you is a perfect system, that it is incapable of improvement, or that would be capable of application as it stands to all other companies. It is the product of 30 years of growth and experience, and I should be sorry to think that its capacity for growth has ceased. But it is a system which does embody all the principles of Co-partnership in an easily recognisable form, and it has shown that it has life in itself and is not dependent upon the continued guidance of the man whose genius gave it birth. It is training up new men all the time, to be ready and able to carry on when those who have proved its value follow its founder into a greater fellowship.

What has the scheme accomplished? There is first its record of 30 years and more of harmony, good will and efficient work. The shareholders, and the consumers, too, for that matter, have benefited from that in dividends, security of capital and the price of gas. There is a matter of some £80,000 of stock held by the employee co-partners, wealth which for the most part

would never have been created had it not been for the scheme; and had it been created would certainly never have been saved. Those are the direct material benefits both to capital and labour. The indirect benefits may be less tangible; but they are not less important either to the individual or the nation. Of one thing you may be sure, a good co-partner is a good citizen. Old employee co-partners will tell you of the change which has taken place under their eyes in the character of the neighbourhood around the works; the change in the character of the employees themselves; the disappearance of public houses and the increase in the number of co-partners who own the houses in which they live. They will tell you that they are proud of *their* Company; that they believe in co-partnership and cannot understand why others do not take it up.

No doubt, there are many persons here to-night who could tell me why the system which we have followed so successfully hitherto has not been more widely adopted. I should be told, no doubt, that co-partnership is easy for a gas company, because a gas company has no competition. I could almost wish it had not, did I not realise that it is to the intense competition with which it daily contends that the gas industry owes, next after co-partnership, its present efficiency. For more years than I can fully reckon gas has had to fight what has periodically been proclaimed to be a losing battle with electricity, and in the process it has doubled and redoubled its production and its sales. It is not afraid of competition. It is so little afraid of it, that it would welcome the introduction of co-partnership as an accepted part of the constitution of all electricity undertakings!

There are, no doubt, many businesses where our particular form of co-partnership scheme could not be applied. But there is no stock pattern of a co-partnership scheme to which all must conform. Co-partnership is a principle; a new religion of industry; a doctrine, not a dogma. The principle can be kept, though the practice vary. Yet there are vast industries in plenty in this country which are by nature fully as monopolistic as the gas industry has ever been. In those at least a system such as I have described to you could, I am convinced, be introduced and worked with little material variation and with results fully as beneficial as those which our own company has experienced.

I should like to see co-partnership adopted, in the first place, in the coal industry and in the railways and in the electrical industry. I wrote those words before the Report of the Coal Commission appeared, and I rejoice and am encouraged to see that it includes a recommendation for the adoption of profit sharing in the industry. I hope that, if that recommendation is adopted, the experiment will not be allowed to stop there; but will be developed ultimately, and soon, into full co-partnership. I see no reason, but much prejudice and misunderstanding, standing in the way. But prejudice and misunderstanding never yet stood permanently in the way

of progress and commonsense. In that faith I look forward to the day when the industries of England shall be owned by its co-partners and the experiment which Sir George Livesey began 37 years ago shall have worked a new industrial revolution.

DISCUSSION.

THE CHAIRMAN expressed the gratitude of the meeting to Colonel Boraston for his most interesting, illuminating and timely address. He had alluded to the Report of the Royal Commission on Coal and to the late Sir George Livesey, who was a friend of the speaker; he therefore desired to read to the meeting letters which he had received from Sir George Livesey twenty years ago at a time when he (the speaker) had endeavoured, at the instigation of the late Duke of Sutherland, to introduce a co-partnership scheme in the latter's collieries in North Staffordshire. Those efforts had not been successful, but he would never forget the support and enthusiasm of Sir George Livesey. Twenty-five or fifty years hence Sir George Livesey's name would probably be regarded with affection and admiration when the names of many people now called great would be forgotten. In 1906 Sir George Livesey wrote to him as follows:—

"The general idea of co-partnership is to give the workman an interest in the welfare and prosperity of the business beyond their wages or salaries. The method of applying the principle, however, differs with the conditions of the business. For a gas company's business is not the same as a colliery, nor a colliery the same as a manufacturing business; consequently, our adaptation of the principle would not, I think, do for a colliery. But I see no reason why it should not be applied in varied form to almost any business.

"In our case the bonus is in the form of a percentage on salaries and wages dependent on the price of gas—if the price goes down the bonus rises, and vice versa, the same as the dividend of the shareholders where the sliding scale is in operation.

"We started with two objects of equal importance; to attach the men to their employers and thereby to induce them to take a real interest in their work, and secondly, to enable them to improve permanently their position in life by saving their annual bonus and thus making themselves property owners. If this is not attained there is failure, for unless the men are really and permanently benefited no good will be done; sooner or later the first named object will fail and the end will come.

"We have induced our people to invest in the Company's stock, and when they are shareholders they take a much greater interest in the Company. They become in fact partners, which Mazzini prophesied would be the ultimate position of the workman.

"Very often the profit-sharing bonus is paid annually in cash, which generally does more harm than good, for instead of encouraging thrift, it really does the reverse.

"I have found that working men will be thrifty if it is made easy for them, but it needs patience and an earnest desire to help them. And then it is most important to discriminate—good, bad and indifferent must not be treated alike, for if so all good results soon cease. If a man persistently is indifferent about his work he is told that until he alters he will be shut out of the co-partnership."

In a further letter, Sir George Livesey wrote:—

"Don't dismiss the idea of the men's bonus being invested in the colliery without an effort to see whether it can be done. A few years back some of the able leaders of the Northumberland Miners' Union approved the idea, but I think their difficulty was that they did not see their way with the Coal Owners. If the latter had been willing to start a system of profit-sharing it is quite likely the thing would have been done.

" Partnership in the business is the idea, and profit-sharing is the means whereby the men get the money for the investment. It is in fact almost the only means, and when in operation becomes co-partnership—a far better term.

" Mazzini said to the workers—

" ' You were slaves, then serfs, now wage hirelings, and you must ultimately become partners.'

" What the Labour Party wants is a better and more even distribution of property which is right enough, but there is a right and a wrong way, and I fear they are going the latter—the way of socialism—I think the South Metropolitan have adopted a better way. At any rate, the employees have in 15 years acquired some £300,000 and are practically all owners of property mostly in the Company's stock, and on deposit with the Company, while with many of them the money has purchased a house.

" I think employers may do a great and good work in this direction, but they must make up their minds that it means hard work, and then a great reward, as we have found."

He (the speaker) thought that the Royal Commission which had recently reported in respect of the coal mines had produced a report which he had no hesitation in saying would go down in history as a very great document. While there were points as to which he was in disagreement, taken as a whole it was a very remarkable document, produced by four men who had approached the subject with absolute singleness of purpose. That report contained an expression of opinion in favour of co-partnership ; that alone was a matter of great interest, and he advised everyone to study that report with great care ; it was a document which marked a great departure in the industry with which he (the speaker) had been connected for the last forty-two years. He thought that the way of social advancement of the great mass of the people in this and other countries in the future lay not along the lines of what was understood by the words " Socialism " and " Communism", because that was bound to fail, but as that far-seeing man Mazzini prophesied, along the line of co-partnership.

MR. W. A. APPLETON, C.B.E. (Secretary, General Federation of Trade Unions) expressed his appreciation of the efforts of the Royal Society of Arts in bringing this subject before the public. He was very glad that the Lecturer had emphasised the point that co-partnership was a principle and not a dogma. A few years before on going to Bradford to make some observations on co-partnership he had been met by a demand for a scheme which would fit every business in Bradford. Of course, that was impossible ; the head of every business who wanted to adopt a successful scheme of co-partnership must think out the details for himself. Trade Unions in the past had opposed co-partnership. They had done even more foolish things than that. Their opposition to co-partnership had been to a great extent due to their fear that their influence might be weakened with the industrial population. There was not the same cause for that fear to-day, because the Trade Unions had permitted the State to weaken their influence very much more than any scheme of co-partnership could do. He had never come into contact with people who were

really interested in co-partnership who could have any conception of a co-partnership scheme without the assistance of the Trade Union movement. Co-partnership was becoming popular, and even Trade Union leaders were human enough to desire to be on the popular side. There was, however, a problem which arose in that co-partnership tended to provide for the most capable workmen who had a tendency towards thrift and who were intelligent enough to realise that it was better for them to come into the scheme; a residuum was then left of those who were not up to that standard. It might be said that such persons would have to go the way which inefficiency always went, but they did not want to adopt that attitude. Those who were inclined to criticise the attitude of the Trade Unions with regard to this matter should remember that some of the trade unionists who looked ahead and were altruistic at heart did fear that there would be left upon their hands a very large residuum of men and women who would never be persuaded to care very much for themselves and who were always willing to depend on anything rather than their own exertions. If such persons could be persuaded that something could be done to meet that problem without increasing the spirit of pauperism which had grown among employers as well as among workmen during the last twenty years, many of the best members of the Trade Union movement might be persuaded to assist the scheme. He personally would certainly draw the attention of his Trade Union Committee to the matter. It was desirable that in any co-partnership scheme there should be responsibility as well as emolument. If one appealed to the men to come into the scheme because something could be got out of it, one would be faced with great difficulties in the inevitable event of there coming a time when there was no profit to distribute. It was necessary to make shareholding quite easy. Many people taked very glibly of having a share in the management. Management, however, must be limited to a very few people. A business which had to wait for the vote of all its employees before it could take action would very soon find itself in the Bankruptcy Court. These appeals for a share in the management were not justified by the possibilities of management; people did not desire management so much as to be assured that they were going to be dealt with fairly, and that, if they made extra efforts, they would receive an extra share. It was necessary that the men should realise that under a profit-sharing scheme they must be prepared to face losses as well as profits. If that could be done, then a great deal would have been done towards educating the men and scotching nine-tenths of the rubbish which was talked on platforms at the present time.

The Chairman expressed the gratitude of the meeting to Mr. Appleton for his wise, helpful and statesmanlike speech; it was that sort of speech that helped the world along.

Mr. H. V. Roe said he had approached the subject of co-partnership with sympathy, and twenty years before had, in fact, started a profit-sharing scheme in his own business. After two or three years, however, his employees themselves had suggested that the scheme should be dropped, as the profits were not large enough to justify it. He had not started the scheme with the object of getting his workers more interested; it was because they were so interested and because they had worked so hard that he had thought they ought to have a share in the business. At the present time he was opposed to profit-sharing schemes. The Lecturer had said that it was " a policy in support of which its advocates could point to numerous practical examples," and that the idea was being " already widely

accepted." The Report on this subject, issued by the Ministry of Labour in 1924, showed that out of the many companies which might have adopted profit sharing schemes only 500 had done so. Out of that very small number more than half had abandoned profit sharing, in some cases because of the dissatisfaction of the employers, and in other cases because of the dissatisfaction of the employees. It could not, therefore, be said that there were numerous examples, or that the idea was so widely accepted. It had also been said that the employees had achieved "a substantial share in the ownership," but the report to which he had already referred, as far as he remembered, indicated that the average was only 2 per cent. of the shares of the companies which adopted profit-sharing schemes. The Lecturer had said that it was necessary that the employee should receive a reward outside of and in addition to the standard rate of wages in his trade. That was a perfectly good principle, and it was achieved more successfully by adopting a system of payments by results. In that case the man drew his money at the end of the week and really saw the definite return for the work he had done; while under a system of profit sharing the man had to wait until the end of the year before he knew whether there was a profit or not. The rise and fall of profits had very often no reference to labour; for instance, the Chairman of the Leatherhead Gas Company, which Company was now applying for powers to adopt profit sharing, &c., had recently pointed out that the profits had been reduced because the price of residuals had gone down, while the price of coal had gone up. Profits very often had no relation to labour at all; they depended far more on the management than on the men. Workers were, therefore, far better paid by a system of payment by results than by profit sharing. The Lecturer had emphasised the good feeling which was promoted by profit sharing. He (the speaker) quite agreed that good feeling between employers and employees was vitally essential; this, however, was achieved far better by Whitleyism, and what was good in profit sharing was really Whitleyism. The Lecturer had said that the Works Committee had proved to be a most useful concession to human nature. That again was Whitleyism. The gas industry was in a position different from that of all other industries; gas companies did not really know what competition was, because they had a monopoly in their own sphere and their own area. Electricity did not constitute any effective competition to gas. A certain gas company had suggested an increase in the standard price of gas owing to their adoption of a profit sharing scheme to enable them to make profits to distribute to their employees. Such a suggestion was absurd. While he appreciated that the price of gas might reasonably be increased for the purpose of supplying a sports ground or anything of that kind, he felt that the suggestion that an extra charge should be made for gas because of something which they chose to call profit sharing, was indefensible.

Commander P. Harrington Edwards, D.S.O., expressed his appreciation of the paper and the speech of Mr. Appleton; if all Labour leaders were like Mr. Appleton, England would be a different country. The report of the Royal Commission was a most excellent piece of work, and those who were interested in co-partnership must feel particularly proud to find that the Commission had adopted their ideas and had, in fact, gone further, because they had said that co-partnership should be compulsory, which was more than they themselves had dared to say. The evidence put before the Royal Commission by the Co-Partnership Association had not been the evidence of one man, or of one class; it consisted of the evidence of over fifty men who

knew their subject and who were of all classes, the greatest attention of all being paid to the working classes and the Trade Unionists. It had seemed to those who had taken part in that work that it was necessary to remove the well-merited suspicion that the workers had of some co-partnership schemes. All co-partnership schemes were not by any means perfect; in fact, some of them were not started with the idea of benefiting the worker, but of benefiting the employer. In reference to the coal trade, there was a very serious pitfall to be avoided. So many collieries had been started many years ago. If a colliery had started with a capital of £500,000, but had since had nearly all its coal worked out, that £500,000 might still appear on its balance sheet as an asset. If a co-partnership scheme was founded on such a balance sheet, one was starting on a false basis; it was necessary to have a re-valuation of collieries, so that when a co-partnership scheme was started, the collieries would be represented in the balance sheet at their real value. That was a difficult thing, but not an impossible thing when one considered that it was in everybody's interests to do it. They did not, of course, suggest that the collieries should write off their capital; the re-valuation of the collieries should be made merely for the purpose of determining what share of profits should go to the men, while the distribution of the profits which went to the owners could be decided, if desired, on the unreal capital basis, so long as the men were not penalised by such fictitious valuations. That, he thought, constituted the crux of the problem with regard to coal mines. The mines which were worked out would have to go the way of all businesses that were worked out; but co-partnership would make the transition period less painful and would give a little time for the labour employed in those mines to seek employment elsewhere.

Mr. James Cawson said that while appreciating the great advantages which might be derived from co-partnership in large industries such as the coal industry, referred to by the last speaker, he felt that the fluctuations which were inevitable in small businesses were such that it was practically impossible to create a reserve fund to cover all eventualities. In limited companies the co-partnership scheme might easily be adopted, and was certainly very successful in Gas Companies, but when one came to adapt the same principles to private concerns, it might be impossible to make proper arrangements for ensuring the profits of the workers, and even in the case of Limited Companies there would be the danger of watering the capital in order to increase the number of shares and thereby weakening the business. All shares did not enjoy as free a market as the shares of Gas Companies, and it might in many cases be impossible to purchase shares for distribution among the workers.

Mr. Percy Rosling said the industry in which he was engaged was not the gas industry, but was one very much subject to competition and to fluctuation in the number of hands employed. He supposed that in the gas industry there had been a steadily growing output for years, and they could offer permanent employment to their men. In the engineering industry, however, one had to pay off one's employees from time to time, and subsequently engage strangers, and in such an industry it appeared to be impossible to adopt any scheme of co-partnership with any degree of success. Undoubtedly people who possessed capital were either those who had been thrifty themselves or were the fortunate sons of thrifty parents or grandparents. Capital was only accumulated by thrift. In the engineering trade there was no reason why a young unmarried man earning £3 a week should not save £1 a week and acquire an interest in the concern in which

he was employed. If they could educate the workers in that kind of thrift, he thought more lasting good would be done than by trying to adopt some specious co-partnership scheme which was dependent upon giving. The Lecturer had attributed the improvement in the circumstances of his employees to co-partnership, but that claim seemed hardly justifiable. He (the speaker) had been interested in a factory for some forty years; during that time they had experienced no labour troubles among their workers, who were contented and proud of the firm for which they worked. In that factory they had not adopted any co-partnership scheme. He could remember the days when the work girls wore woollen stockings and clogs, whereas to-day they wore silk stockings and high-heeled shoes. The general improvement in the condition of the working class was not attributable to co-partnership. The Lecturer had referred to the efficiency of American industry, but he (the speaker) attributed that efficiency largely to climatic conditions.

Mr. E. W. Mundy (Secretary, Labour Co-partnership Association) said the ideas put forward by Mr. Roe had already been entirely contradicted both in theory and in practice; he himself had met Mr. Roe in public debate and absolutely and entirely defeated him; he also had quite recently written to the press offering to do the same thing as often as Mr. Roe liked.

Co-partnership schemes in America depended on the purchase of capital by the workers, and their success was due to high wages, which afforded the worker a far greater opportunity of saving than the majority of workers in this country had. He believed that over a large part of British industry it was almost impossible for a married man with a family to effect any real saving. Individual initiative and individual efficiency could be encouraged by some system of piece-work and the premium bonus system, which were used in conjunction with systems of co-partnership. But the advantage of co-partnership consisted in producing collective efficiency by bringing the whole of the work-people into a scheme, so that they felt they were all working together as a whole and as a team, or, as one might say, as brothers in fellowship. If certain of the workpeople took up capital while others did not, he did not see how one was to secure that corporate feeling, because, as a matter of fact, the work-people would be separated into classes of worker shareholders and worker non-shareholders. Capital must receive the reward proper to itself, while the worker must be rewarded according to his work. The idea of encouraging the worker to take up shares in the concern in which he was employed was an excellent one, but it was not co-partnership, because it did not reward the worker according to his work. A man might be enabled to become a shareholder by having money left to him by a wealthy relative, whereas by his side a hard worker who was a married man with children and who might be one of the best men in the works, might have no money with which to buy shares, so that the one man was going to get a share of the profits of his work, while the other was not going to get a share of the profits of his work. Co-partnership consisted in giving the workers a dividend upon their wages, something which was coming to them because they were workers, and not something which was coming to the worker because he was a capitalist. No one would be so foolish as to suggest that one should reward a capitalist according to his work; why, then, should it be suggested that one should reward the worker according to his capital? It was desirable to do everything possible to encourage the worker to save and invest his money in the industry in which he was employed, but when they considered co-partnership, it seemed to him it was much wiser to consider it as being linked

up with profit sharing, so that all the workers became capitalists as in the case of the South Suburban Gas Company. In that way one achieved the co-partnership spirit, all the men working together, feeling for one another; and, moreover, one achieved that collective efficiency in the business, which was the object of co-partnership.

THE CHAIRMAN said there was no doubt that, whether they liked it or whether they did not, co-partnership was going to stay. There were two big thoughts which he carried away from that meeting, which seemed to him to epitomise the whole of the admirable lecture: firstly, co-partnership was industrially sound; and, secondly, that it offered a reward outside and additional to standard wages. If they carefully considered those two texts, he was sure they would come to the conclusion that co-partnership was the right thing. He very strongly agreed with the necessity of thrift which had been emphasised by other speakers. Many capitalists to-day were the grandchildren of those who had worked in the concerns which they now owned. That statement was abundantly true of the coal industry; in fact, it was true of about 70 per cent. of the coal owners. It was desirable that everyone should be a capitalist and that everyone should work. There was to-day a terrible need for work.

MR. W. H. NEVILLE said he was an employee, and spoke on behalf of a large number of fellow employees who were engaged in the Gas Light and Coke Company, which had adopted a profit-sharing scheme. He appealed to those present who were employers of labour to realise that, if they wanted co-partnership to be successful, they must trust the workers. He spoke as a trade unionist and a leader of men in a humble way, and he was firmly convinced that the salvation of the working class movement in England lay in the adoption of co-partnership in some form or other. But it was necessary that the workmen should be given greater opportunities. Co-partnership was not successful in the Gas Light and Coke Company, where they were not getting the best either from the men or the staff. One reason for that unsatisfactory state of affairs lay in the fact that for a long time the employees of the Gas Light and Coke Company had been endeavouring to obtain representation on the Board of Directors, so that they would be able to speak from their side of the business straight to the directors; but each time they had appealed, their application had been "turned down." In his opinion that was not right. If one desired to get the best from the workers, it was necessary that one should trust them, that one should get among them and encourage them by kindly words and deeds as well as promises and glowing accounts of prosperity. Every time that the men's application for a directorship was rejected, they became disheartened and their efforts were gradually declining. Co-partnership could only be successful when the employers added to the responsibilities of the employees by asking their advice and by having one or two workmen who were trusted by the men on the Board of Directors.

THE CHAIRMAN expressed his gratitude to the last speaker for what he had said; trust was of the very essence of co-partnership, and the very best method of showing one's trust was by affording representation of the men on the Board of Directors.

MR. C. J. CARTER said he was an employee who was also a Director of the South Suburban Gas Company. Whilst he represented the working co-partners on

the Board of the Company, Colonel Boraston represented the shareholders as a whole, but their votes were of equal weight. In that Company the Directors who were employees did not concern themselves merely with matters affecting the workmen, but took their part in the whole of the business of the Company. When Colonal Boraston joined the Board of the South Suburban Gas Company, he entered one of the best possible schools in which to learn something of the application of co-partnership. He (the speaker) had been connected with that Company for 27 years; when he joined he had possessed nothing beyond the current week's wages; now he was a considerable shareholder and possessed the necessary financial qualification for representing the co-partners on the Board of the Company. He was Secretary of the men's side of the Works Committee. He could substantiate everything that the Lecturer had said as to the co-partnership system in that Company.

Colonel Boraston, in reply, said that the last speaker had very truly said that he had attended a good school; in that school one of his ablest teachers had been Mr. Carter. It had been suggested that co-partnership might lead to the watering of capital. That, of course, was not a thing which anybody would recommend, and there was no need in applying co-partnership to produce that result. The South Suburban Gas Company by its very nature was enabled to adopt a full and complete form of co-partnership; there were private concerns in which it would be impracticable to apply the system to the same extent; but that did not mean that the principle of co-partnership could not be applied. The principle was that the employee should share in the profits of greater application and greater good will, and that his share should have a practical result in improving his position by the encouragement of thrift. Those two principles could be applied without representation of the workers on the Board of Directors and in concerns other than share-holding or limited liability companies. In the small private concern the employee and the employer were brought into such close touch with one another that they did not experience the difficulties with which the big concern was faced. The profit which was allocated to the workers need not necessarily be invested in the concern itself, though it was preferable that it should be. Where it could not be invested in the concern itself, it should, if possible, be invested in the industry. Messrs. Taylors, who had so successfully adopted the profit-sharing system, when they found their shareholding was getting so large that it was more than the Company could stand, had invested the workers' profits in War Loan. The principle could be applied in many ways, but in order to get the full benefit of that mutual trust, which was so necessary to a complete system of co-partnership, one should, wherever the circumstances of the business permitted, follow the full logical development which the City Suburban and the South Metropolitan Gas Companies had pursued.

The meeting concluded with a vote of thanks to the Lecturer.

NOTES ON BOOKS.

The Roman Road to Portslade. By James Dunning. London: Hatchards. 7s. 6d. net.

Here is a book which should be in the library of every Briton who is deeply interested in the early history of his country, the author taking his readers back to the times when the Romans maintained what may perhaps be called a predominating

influence in Britain, if we average matters from the first raid under Cæsar to the final departure of the Roman armed forces nearly five hundred years afterwards. Manley Pope, in the preface to his History of Ancient Britain (2nd. Ed. 1866, p.III.) refers to Britain as being "a nest of hornets to the Roman Power," but nevertheless those from the mighty mother of nations contrived to carry out, promote or stimulate a vast amount of road-making in Britain, whether for war or commerce.

The author clearly and convincingly contends that there was formerly a great commercial road between London and Portslade, and he hopes to bring about combined action with a view to tracing the whole course of this road. Further, he suggests that Portslade, not Portchester, is the real Portus Adurni, but he says on page 5 "whatever it (Portslade) was named, it was intended to be one of the key positions in the trading economy of Roman Britain."

As regards the Southern Coastal ports and the early civilisation of Britain, Milton's History of England, with its abundant references to North European authorities, also to the more independent Roman authorities, as Capitolinus, Dion Cassius, Eutropius, Juvenal, Spartianus, Martial and others, is a good basis on which a diligent student may commence.

When treating of that culminating onslaught of the Saxons which made them masters of South Britain (about 500 A.D. or 80 years after the Roman armed forces had departed) Milton writes thus of Portsmouth and the origin of its name: "Porta, another Saxon, with his two sons Bida and Megla in two ships arrive at Portsmouth thence called, " (Milton, Hist. Eng. Ed. of 1677, p. 141). If we accept this, and several confirmations are available, half-a-dozen localities near Portsmouth may possibly be regarded as named after the victorious Porta. We find Portsmouth, Portsea, Portsdown, Landport, Gosport and Portchester closely grouped together, with Portslade a little to the east; the Saxon adjuncts to Porta's name being muth, sæ, dun, land, gos, ceaster, and slæd. Earlier Roman names are indubitable in some cases as Portus Magnus for Portsmouth Harbour, but the steady and persistent activity of the Saxons during the Roman occupation, as also Saxon names surviving for the great roads, suggest active participation, at any rate as far as maintenance is concerned. Perhaps it is more to the purpose to plead broadly for somewhat fuller recognition of Saxon influence during Roman times than present day historians give.

As bearing on early influence from far-off lands, we may mention Milton's remark on p. 60 of his history in the 1677 edition mentioned above. Milton says of the Druids that "Plinie writes them skilled in Magic no less than those of Persia." If we now turn to Pliny's Latin original of the "Natural History," we find that Book XXX is devoted to Medicine, and at the commencement the old magic (broadly natural science) of Persia is touched on as having arisen out of Medicine. Pliny distinguishes quite lucidly between false and true sciences, but he evidently considers the teachings of the Magi and more especially the doctrines of the Archimagos Zoroaster (whom he places about six thousand years before Plato and Aristotle), as false science. Pliny, however, seems very much at a loss to account for any aspect of Eastern or Persian science having become established in Britain.

Perhaps this mention of Druidical learning by Pliny may be regarded as slight confirmation of the legends which tell us of a Dardanian or Trojan infusion.

Milton embodies in his history the story of the Trojan Kings (as Lear, Ludd, and Bladud or Vlatos), but with a suitable cautionary introduction, and Harvey in his Defence of Brutes Historie (1592), gives many interesting details of London in his day as bearing on the Brutan legends. Manley Pope, in his 1866 edition mentioned above, gives certain confirmations which have come to light since Milton's time.

Every student who has interested himself in the pre-Norman period, or we may say every Briton, should take pleasure in carefully reading our author's book, and once read it may often be removed from the shelf and give rise not only to meditations on those great peoples of by-gone days who are factors in the British race, but also to wanderings in the paths and among the downs which are described.

GENERAL NOTES.

STATISTICS OF BRITISH SHIPPING.—In a Paper recently read before the Royal Statistical Society, Mr. H. W. Macrosty said that at the end of 1918 the British mercantile fleet was about one-sixth below its pre-war strength, but to-day it had practically recovered its position. The addition of new vessels was proceeding at only about three-fourths of the pre-war rate, and the increase of our tonnage was in part due to the assignment to this country of over 2,000,000 gross tons of enemy shipping. Since 1918 over 3,000,000 net tons of shipping had been sold to foreigners, over 30 per cent. of which had gone to Italy and Germany. The breaking-up of old ships had gone on at a very slow rate. Since pre-war days the smaller class of ocean-going steamer, between 1,600 and 5,000 gross tons, the "tramps." had decreased heavily in number and tonnage, while "cargo liners," between 5,000 and 7,500 gross tons, and "passenger-liners," over 7,500 gross tons, had largely increased. The relation of net to gross tonnage showed a general increase in carrying capacity, due mainly to structural improvements, and as the number of large motor vessels grew this increase would be more noticeable. Study of the age-constitution of the ships showed a great growth in newer vessels over 5,000 gross tons, so that the efficiency of our merchant vessels was to-day greater than before the war, but the decline in shipbuilding contained a danger for the future.

THE BRITISH ASSOCIATION.—The annual meeting of the British Association will be held at Oxford from August 4-11. The Presidential Address, by H.R.H. The PRINCE OF WALES, will deal (*inter alia*) with relations between scientific research, the community, and the State, both at home and in the Overseas Dominions. Among the principal subjects expected to be dealt with in Sectional Addresses and Discussions are the following :—The Production and Analysis of Spectra. The Scope of Organic Chemistry. Present-day Scientific Problems in Fuels. The Study of the British Lower Carboniferous Rocks. The Conception of a Species. Biology and the Training of the Citizen. The Value of Tissue Culture in Biology. The Economic Development of British Tropical Africa. Inheritance as an Economic Factor. Economic Aspects of the Financial and Labour Outlooks. Electricity Supply : Recent and Future Developments. Refrigeration. The Evolution of Human Races. Inheritance of Physical and Mental Characters in Man. Function and Design (Physiological aspects). Acclimatization to High Altitudes. Psychological Aspects of Social Punishments. Recent Progress in Vocational Selection. Vegetative Propagation. Educational Training for Overseas Life. Educational Value of the Cinema and Broadcasting. Agricultural Education. Cultivation Methods. Dairy Problems.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MAY 3..Architects, Royal Institute of, British 9, Conduit Street, W. 8 p.m. Annual General Meeting.

Chemical Industry, Society of, Burlington House, Piccadilly, W. 8 p.m. Messrs. S. Dickson and Mr. R. H. Harry Stranger, "Modern Portland Cement Manufacture."

Civil Engineers of Ireland, 35, Dawson Street, Dublin. 8 p.m.

Engineers, Society of, at the Science Museum, South

Kensington, S.W. 5 p.m. Mr. H. W. Dickinson, "Landmarks in the History of Prime Movers."

Farmers' Club, at 12, Great George Street, S.W. 4 p.m. Mr. Guy Ewing, "The Progress and Work of Rural Community Councils."

University of London, at King's College, Strand, W.C. 5.30 p.m. M. le Professeur F. Delattre, "La Personnalité d' Henri Bergson et l' Angleterre." (In French); 5.30 p.m. Baron A. F. Meyendorff, "Russian Thought on Problems of Ethics." (Lecture I.); 5.30 p.m. Dr. Otakar Vocadlo, "The Place of the Czechs in the Slavonic Family." (Lecture I.)

At University College, Gower Street, W.C. 5 p.m. Prof. F. M. Stenton, "Modern English Historians: (1) "Maitland"; 5 p.m. Prof. G. Dawes Hicks, "Hegel's Aesthetics." (Lecture I.)

At the Imperial College, Royal School of Mines, South Kensington, S.W. 5.15 p.m. Prof. Sir T. W. Edgeworth David, "Past Ice Ages of the World." (Lecture I.)

Tuesday, May 4..University of London, at University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. G. E. Moore, "Universals and Particulars."

At the Institute of Historical Research, Malet Street, W.C. 3 p.m. Mr. Vladimir Burtsev.

Wednesday, May 5..Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Dr. R. L. Smith-Rose and Mr. R. H. Barfield, "On the Cause and Elimination of Night Errors in Radio Direction Finding."

Geological Society, Burlington House, W. 5.30 p.m.

Public Analysts, Society of, Burlington House, Piccadilly, W. 8 p.m. Mr. A. Chaston Chapman, "The Detection and Determination of Glycerin in Tobacco." Mr. Harold Toms, "Further Notes on the Crystalline Bromides of Linseed and other Oils." Messrs. A. Bakke and P. Henegger, "The Polarimetric Determination of Sucrose in Condensed Milk." Messrs. Henry L. Smith and J. H. Cooke, "The Determination of very small Quantities of Iron." Dr. W. R. Schoeller, "The Separation of Iridium from Iron." Mr. Jitendra Nath Rakshit, "The Determination of Total Alkaloids, Sugar and Oily Substances in Opium."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. F. E. Farrer, "Tenancy by the Curtesy of England"; 5.30 p.m. Prof. Louis Eisenmann, "The Imperial Idea in its German and in its Byzantine Form." (In French.)

At University College, Gower Street, W.C. Dr. W. C. Bolland, "A Study of the Year Books." (Lecture II.) 5.30 p.m. Prof. Didrik Arup Seip, "Norwegian a Language in the Making." (Lecture I.)

At the London School of Economics, Aldwych, W.C. 5.30 p.m. Prof. P. J. Noel Baker, "Practical Problems of Disarmament—Lecture II. "Naval Disarmament."

Thursday, May 6..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, Burlington House, W. 8 p.m. Messrs. C. K. Ingold, E. Holmes and E. H. Ingold, "The nature of the alternating effect in carbon chains. Parts IV., V., VI., and VII." Messrs. C. K. Ingold, C. W. Shoppee and J. F. Thorpe, "The mechanism of tautomeric interchange and the effect of structure on mobility and equilibrium. Part I. The three-carbon system." Messrs. K. E. Cooper, C. K. Ingold and E. H. Ingold, "The correlation of additive reactions with tautomeric interchange. Part V. The structural conditions affecting mobility and equilibrium."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Annual General Meeting.

Iron and Steel Institute, at the Institution of Civil Engineers, Great George Street, S.W. At 10 a.m. and 2.30 p.m. Annual Meeting. 1. Report on the Heterogeneity of Steel Ingots. 2. Mr. D. Brownlie, "Coal Blending." 3. Messrs. A. E. Cameron and G. B. Waterhouse, "The Effects of Arsenic on Steel." 4. Messrs. E. D. Campbell and H. W. Mohr, "Specific Resistance and Thermoelectro-motive Potential of some Steels differing in Carbon Content." 5. Messrs. W. H. Dearden and C. Benedicks, "Magnetic Changes in Iron and Steel below 400° C." 6. Mr. J. H. S. Dickenson, "A Note on the Distribution of Silicates in Steel Ingots." 7. Messrs. R. H. Greaves and J. A. Jones, "The Ratio of the Tensile Strength of Steel to the Brinell Hardness Number." 8. Mr. W. W. Hollings, "Notes on the 'Combustibility' of Coke and Direct Reduction in the Blast Furnace." 9. Mr. H. O'Neill, "Deformation Lines in Large and Small Crystals of Ferrite." 10. Mr. A. Osawa, "The Relation between Space-Lattice Constant and Density of Iron-Nickel Alloys." 11. Mr. A. R. Page, "The Hardening and Tempering of High Speed Steel." 12. Messrs. T. E. Rooney and L. M. Clark, "The Estimation of Phosphorus in Steels containing Tungsten." 13. Messrs. W. Rosenhain, R. G. Batson and N. P. Tucker, "Effect of Mass in the Heat Treatment of Nickel Steel." 14. Messrs. I. G. Slater and T. H. Turner, "The Hardness of Carbon Steels at High Temperatures." 15. Mr. J. H. Whiteley, "Ghost Lines and Banded Structure of Rolled and Forged Mild Steels." 16. Messrs. G. R. Woodvine and A. L. Roberts, "Influence of Segregation on the Corrosion of Boiler Tubes and Superheaters."

Linnean Society, Burlington House, W. 5 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir W. Bragg, "The Imperfect Crystallisation of Common Things." (Lecture II.)

Royal Society, Burlington House, W. 4 p.m.

Structural Engineers, Institution of, at Denison House, 296, Vauxhall Bridge Road, S.W. 7.30 p.m. Annual General Meeting. Major James Petrie, "Some Lessons from practical experience with special reference to Structural Work on Railways."

University of London, at the Imperial College of Science, South Kensington, S.W. 5.30 p.m. Brig.-General H. B. Hartley, "Chemical Warfare."

At the London School of Economics, Aldwych, W.C. 5 p.m. Mr. D. H. Robertson, "Projects of Monetary Reform." (Lecture I.)

At University College, Gower Street, W.C. 5.30 p.m. Prof. Edmund G. Gardner, "The Poets of Risorgimento."

Friday, May 7..Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Dr. D. R. Grantham, "The Petrology of the Shap Granite"; Mr. G. W. Young, "Notes on the Shoshone Valley, Yellowstone National Park, U.S.A."

Iron and Steel Institute, at the Institution of Civil Engineers, Great George Street, S.W. 10 a.m. and 2.30 p.m. Annual Meeting. (See list of papers under May 6).

Mechanical Engineers, Institution of, Storey's Gate, Westminster, S.W. 6 p.m. Fourth Report of the Marine Oil-Engine Trials Committee. (Joint Meeting of the Institution of Mechanical Engineers and the Institute of Marine Engineers.)

Philological Society, at University College, Gower Street, W.C. 8 p.m. Anniversary Meeting.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir F. G. Kenyon, "English Illuminated Manuscripts."

Philosophical Studies, British Institute of, at 52, Upper Bedford Place, W.C. 5.30 p.m. Prof. E. F. Carritt, "Contemporary Data for Aesthetics."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Dr. J. Kay Jamieson, "The Nature and Functions of the Fasciæ of the Human Body." (Lecture II.)

At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. E. Beddington Behrens, "International Problems of Industry." (Lecture II.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prof. Louis Eisenmann, "The Reign of Francis Joseph." (In French.)

Saturday, May 8...Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. P. C. Buck, 1. "Song Form in England." 2. "Parry."

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CONTENTS:

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

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FRIDAY, MAY 7th, 1926.

All communications for the Society should be addressed to the Secretary, John Street. Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, MAY 12th, at 8 p.m. (Ordinary Meeting). WARRE S. BRADLEY, "Industrial Welfare in Practice." SIR ROBERT A. HADFIELD, BT., D.Sc. F.R.S., will preside.

CANTOR LECTURE.

MONDAY, MAY 3rd, 1926. MR. CHARLES REED PEERS, C.B.E., M.A., Director of the Society of Antiquaries, Chief Inspector of Ancient Monuments, H.M. Office of Works, delivered the third of his course of three lectures on "Ornament in Britain."

On the motion of the Chairman, a vote of thanks was accorded to Mr. Peers for his interesting course.

The lectures will be published in the *Journal* during the Summer recess.

SEVENTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 28th, 1926. BRIG.-GENERAL SIR HENRY P. MAYBURY, R.E., K.C.M.G., C.B., M.Inst.C.E., Director General of Roads, Ministry of Transport, in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

Nicholson, Commander Richard Lindsay, R.N., D.S.O., Delhi, India.
Quinnell, Richard, London.

The following candidates were duly elected Fellows of the Society:—

Achariar, T. M. Daivasikhamani, Washermenpet, Madras, India.
Adeeb, Emile, London.

Benzie, George William Gledhill, Udarband, Cachar, India.
Bledisloe, Rt. Hon. Lord, K.B.E., London.
Brough, Thomas, J.P., Halstead, Essex.
Clarke, Captain Sir Arthur Wellesley, K.B.E., London.
De Silva, K.G.C., Colombo, Ceylon.
De Zoysa, Garumuni Arthur, London.
Faizuddin, Saiyid, Nagpur, India.
Fergusson, John Carlyle, B.A., I.C.S., Agra, India.
Hughes, The Rev. Robert, Ph.D., D.C.L., Llandudno.
Knight, Hugo Sidney, London.
Lannon, John D., Buffalo, New York, U.S.A.
La Wall, Charles H., Sc.D., Philadelphia, Pa., U.S.A.
Lupton, John Thomas, LL.D., Chattanooga, Tennessee, U.S.A.
Northumberland, His Grace The Duke of, K.G., London.
Zilen, Victor W., Buffalo, New York, U.S.A.

A paper on "Horse Traction and Motor Traction" was read by MR. JAMES PATERSON, M.C., (of Messrs. Carter, Paterson & Co., Ltd.)

The paper and discussion will be published in the *Journal* dated June 4th.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, 19TH MARCH, 1926.

THE VISCOUNTESS CHELMSFORD, G.B.E., in the Chair.

THE CHAIRMAN said she almost thought she was back again in India, taking the Chair at a meeting dealing with a subject such as was to be discussed that day, because there was not only a large audience but also a good representation of Indians who were interested in the subject. She was delighted to find that so many people had come to listen to Lady Chatterjee who was to speak on the subject of Women and Children in Indian Industries.

She was particularly glad to take the Chair that afternoon, because it was one of the questions that interested her almost more than any other during the time her husband was Viceroy. She knew that the lecture would be exceedingly interesting, and she would do no more at present than simply introduce Lady Chatterjee; she did not believe it was necessary to do so more than formally. Lady Chatterjee was the wife of the High Commissioner of India. She had laboured a great deal in India, going out there at the request of the Government of India to make a special study of the subject regarding which she was now going to speak.

The following paper was then read:—

WOMEN AND CHILDREN IN INDIAN INDUSTRIES.

By LADY CHATTERJEE, O.B.E., M.A., D.Sc.

Late Adviser to the Government of India on the Industrial Employment of Women and Children.

The last thirty years have been marked by a considerable advance in India's industrial development. To this advance women and children

workers have contributed in no small measure. They have taken an increasing part in the development of the great textile industries, of the mining industry and of the tea industry, as well as in many of the lesser industries. Figures are available showing that while in 1892 there were 43,592 women, 16,299 boys and 2,589 girls employed in organised industries, in 1922 there were no less than 206,887 women, 56,552 boys and 11,106 girls. Or, in other words, in these thirty years the number of women employed in factories has increased five-fold and the number of children more than three-fold. There has been a corresponding increase in the mining industry, but exact figures are not available for the whole period as the first Inspector of Mines in India did not start work till December, 1893, and it was some time before he could obtain detailed returns. In his annual report for 1896 Mr. Grundy, who was the first Inspector, gives figures showing that in the coal mines for which he had received returns there were 7,190 women employed below ground and 9,251 above ground. The figures relating to children are not given separately. In 1922 the figures for the coal mines showed that 39,753 women were working below and 25,036 above ground, also that 787 children were employed below and 3,260 children above ground.

These statistics suffice to show the importance of the problem of the industrial employment of women and children. It is not possible to deal, in the course of this paper, with all the various industries in which women and children are employed. I shall consequently confine myself to the salient facts concerning the three major industries, namely, the organised textile industries, the tea factory industry and the mining industry. It will be my endeavour to give in the case of each of these industries a brief account of the work done by women and children, of the sources of the labour supply, and of the conditions of employment. Finally, some of the general problems arising out of the industrial employment of women and children will be examined.

At first sight it may seem strange that such large numbers of women and children seek factory work instead of being content to do agricultural work which has been their hereditary calling for many generations. The reasons, however, are not far to seek. As Mr. Grundy pithily put it in his first annual report, "the principal reason for females going out to work is to earn money." As this cannot be done at all seasons of the year in agriculture and as there is now a constant surplus population in need of employment, men and women are perforce compelled to leave their work and to seek industrial employment. The majority of them are, however, very loath to sever their ties with the country, for there they can work and live in the way they have been accustomed to do for generations. They are surrounded by their own kith and kin, they can get clean wholesome food and an abundance of fresh air and sunlight. There are, however, many shadows also in the picture of village life. Many of the villages are very insanitary and the hovels in which

the villagers live cannot be described as comfortable. Wages are low, the money-lender is a person whom it is impossible to avoid, and there are long periods in the year when it is difficult to get remunerative employment. This is particularly true in the case of the landless labourer, who forms the chief source of the labour supply of the factories. Conditions are not very much better even for the tenant cultivator. India is a land of small holdings and owing to the Hindu and Muhammadan laws of inheritance a continual subdivision of land is always taking place. Consequently agriculture cannot be conducted on a lucrative basis and a man who finds himself possessed of a tiny holding has frequently to seek work for himself or for a junior member of the joint family in order either to repay a debt or to earn money for improving his land. The alternative or subsidiary resource of factory employment improves very considerably the position both of the landless labourer and of the tenant and has a very favourable reaction on village life. It has been found in some cases that comparatively speaking large sums of money are remitted to the village by those who have sought their fortunes outside. This gives an additional incentive to others to go and do likewise, while those who return from city life bring back with them a greater independence of character and wider views and have less inclination for a meek acceptance of the prevailing primitive conditions in the rural areas.

This brief sketch of village life has been given in order to show the wholesome effect that industrial employment has on rural life. It is also given as a basis of comparison. There are many nowadays who see nothing but evil in industrial life, but, if a true perspective is to be obtained, it is necessary to compare it with the conditions which are prevalent in those parts from which the labour is drawn.

The cotton factory industry is chiefly carried on in the Bombay Presidency, though there are large and important mills in the United Provinces, in the Central Provinces and in Madras. The jute industry is practically the monopoly of Bengal. The principal coalfields are in Bengal and Bihar, while the tea gardens are found in Assam and the mountainous and submontane tracts of Bengal.

The cotton industry gives employment to very large numbers of women and children. In 1923 there were no less than 323,640 persons employed, and of these 57,308 were women and 18,087 were children working in cotton mills, and 129,139 persons, the majority of whom were women, in cotton gins and presses. Conditions vary considerably in the different factories, depending largely on the date of erection. The old-fashioned spinning and weaving mills are huge structures consisting of many floors which are difficult to ventilate and keep cool. The more modern mills are single storey sheds where adequate arrangements can be made for ventilation and lighting. The buildings of cotton gins and presses are frequently very unsatisfactory.

This work is of a seasonal nature and lasts only a comparatively short period. Many gins are consequently little better than tin sheds. In the cotton spinning and weaving mills the, men do the spinning and weaving while the women are principally employed in the reeling and winding department. Children are employed chiefly as doffers in the roving and spinning department. The work of reeling in which the majority of women are employed is not in itself exhausting. It has the additional advantage of being removed from the din of the machinery. The children, however, are not so fortunate. The work of removing the bobbins from the machines has to be done amid the noise and rattle of the machines. In the gins the women have to sit amidst the cotton fluff passing the cotton into the machines and the atmosphere is often very bad. The jute mill industry, which, as we have seen, is localised almost entirely in Bengal, gave employment in 1923 to 327,067 persons, and of these 52,531 were women and 28,612 children. The jute mills seen by me were large, single-storey structures in which, on the whole, satisfactory arrangements had been made for lighting and ventilation. Women take a much larger part in the actual processes of manufacture in the jute mills than they do in the cotton mills. They are to be found in practically all the departments with the exception of the weaving. Men are exclusively employed on all the heavier operations such as weaving, beaming, and on the calendar machines. In the hand-sewing department whole families work together.

The principal coal-fields of India, known as Jharia and Raniganj, are situated on the borders of Bihar and Bengal. In 1924 the total number of employees in all coal mines was 187,088, and of these 41,616 women were employed below ground and 21,994 above ground. The prohibition of the employment of children *below* ground took effect from 1st July, 1924, while the numbers of children employed above ground was 2,391. In the coal mining industry the men hew the coal while the women carry it in baskets on their heads. In an enquiry into "Women's Labour in the Bengal Industries" made in 1922 by Dr. Curjel, of the Women's Medical Service, it was found that, while in the larger collieries every effort was being made to reduce the distance that the coal had to be carried in this manner, in the smaller collieries a woman might have to carry a load of coal weighing from 60 to 80 lbs. a considerable distance (200 yds.) and up a steep incline. The question of the prohibition of the employment of women underground has been under consideration ever since 1894, when it was first mooted. A strong public opinion against such employment is now manifesting itself.

The tea estates in India are found principally in Jailpaiguri and Darjeeling in Bengal and in Assam. At the census of 1921 no less than 215,611 persons were employed in Bengal tea gardens, while the tea estates in Assam gave employment to over 200,000 men and boys and an almost equal number of women and girls. In addition to the extensive agricultural operations that

have to be carried on there is also a large factory industry dealing with the preparation of the leaves. These factories were exempt from the Indian Factory laws until 1922, when the Act of that year brought them within their scope. In 1924 there were nearly 14,000 persons employed in tea factories in Bengal and over 45,000 in Assam.

SOURCES OF LABOUR SUPPLY.

Some of the reasons why agricultural labour seeks factory employment have already been given. Bad harvests, agricultural depressions, small holdings, are all causes helping to swell the ranks of the industrial workers. In addition, security of possession, one of the advantages of a settled form of Government, has increased very considerably the number of persons anxious to hold land. In many tracts also there is severe congestion. We have seen how the landless labourer and the tenant find themselves compelled to seek more remunerative employment. The same is true of the artisan castes of the villages. The hand-weavers and spinners, the potters, the workers in leather and brass who depend on the prosperity of the village for the demand for their goods, find that at a time of agricultural depression their market suddenly shrinks and they are compelled to migrate. In normal seasons, too, machine-made goods, whether of Indian manufacture or imported, are competing very seriously with the produce of village craftsmen and the latter have no option but to seek employment either in the already congested agricultural industry or in factories.

The labour supply for industries is consequently made up of agricultural workers belonging to both the landed and the landless classes as well as the skilled artisan workers from the villages. Moreover, as some of the districts cannot supply the labour they need for their own industrial requirements there is a constant migration of labour over considerable distances in India. This is a very important feature of the labour problem in India and carries with it many serious consequences. Thus we find that in Bombay approximately only one quarter of the industrial workers are employed in their own immediate neighbourhood. More than half come from other parts of the Province, while the remainder come from other provinces and in some cases from very distant parts of India. An immediate consequence of this large migration of labour is the disparity in number between the sexes that is to be found in large cities such as Bombay, where the male population forms nearly two-thirds of the total.

In Bengal the situation is even more serious, for there only a very small proportion of the factory labour is drawn from the province itself. Nearly 70 per cent. of the workers are recruited from other parts of India, the majority coming from the adjacent provinces of Bihar and Orissa and from the congested districts of the United Provinces. An analysis of the workers in the jute mills shows that more than seventy different castes are to be found

there, comprising ordinary labourer-castes, agriculturalists, weavers, workers in leather and other artisan castes. The disparity in the sexes which was found to be a feature of Bombay city is also characteristic of Calcutta, where very much the same proportion obtains of men to women.

The question as to how the tea gardens and the coal mines obtain their labour now remains to be answered. In the Bengal tea gardens situated in Jailpaiguri the majority of the workers are immigrants, more than half coming from Chota Nagpur. On the Darjeeling tea estates more than half the labour is local, the rest coming from Nepal. The Assam tea gardens are entirely dependent on imported labour. Workers come from the distant province of Madras, from the backward tribes living in Chota Nagpur, from the precarious agricultural tracts of the Central Provinces and from the congested areas in Bihar and the United Provinces.

The coal mines, situated as they are in backward agricultural tracts, draw nearly 60 per cent. of their unskilled labour from sturdy local cultivating tribes such as Santals and Bauris. The rest are recruited from other local castes or from distant parts such as the Central Provinces and the United Provinces. Generally speaking, therefore, it is the more backward tribes who are to be found on tea gardens and in coal mines, while factory employment draws men from the agricultural and artisan castes. In the former case the two kinds of work are not very dissimilar, while it is possible to combine coal mining with agriculture by the simple expedient of staying away from the mine, whenever it becomes necessary to look after the tiny agricultural holding. Another important difference between the work in factories and that on tea gardens and in coal mines arises from the fact that in these latter industries whole families can work together. Thus it is possible for a family to migrate with the certainty that all its members will find employment together. In the case of coal mining this certainty is, however, beginning to break down. Children have been prohibited by recent legislation from working under-ground and the question of the prohibition of the employment of women is now under consideration.

Conditions of Employment.

We shall now consider the conditions of employment in the three industries with special reference to hours of work, wages and housing. Let us begin with the textile industries. A very important change that has been effected in recent years, not only in the textile industry but in all factory industries, has been the raising of the age of employment. Prior to 1922 children between the ages of 9 and 14 could be employed for 7 hours a day in non-textile and for 6 hours a day in textile factories. Boys and girls above 14 were reckoned as adults. The Act of 1922 raised the minimum age of employment to 12 and prohibited the employment of children between the ages of 12 and 15 for more than six hours a day in any factory. A rest interval was also prescribed.

In the case of adults the hours of work were restricted by the new Act to 11 per day and to 60 in the week, and a rest interval was also prescribed. Further, in certain circumstances women had been allowed to work at night in ginning factories. This was repealed, and no women are now allowed to work in any factory at night. Another important reform which affected the employment of women and children was to bring a very large proportion of the smaller factories within the scope of the new Act.

We may now turn to the question of wages in the textile industries. The Bombay Labour Office has recently published the results of a careful inquiry on this subject instituted in 1923. The Government of India has also, within the last few months, made available facts ascertained officially regarding periods of wage-payment throughout the country. It brings out the fact that wages in the cotton mill industry in Bombay City are generally paid monthly after a waiting period of twelve to fifteen days. In Ahmedabad they are paid fortnightly, a week in arrears. In the cotton-ginning industry no universal system exists. In Bombay province, for instance, the monthly, the fortnightly, the weekly and even the daily system of the payment of wages are found to prevail in different factories.

With regard to the actual amount of wages paid reference can only be made to the general averages given in the Bombay Labour Office Report. It appears that the average monthly wage earned by women in August, 1923, in Bombay City was Rs. 17. 5a. 5p. and by children half that amount. In Ahmedabad women earned slightly more, while in Sholapur they only earned Rs. 8. 9a. 7p. These wages do not represent the potential monthly earnings as on an average out of one hundred working days women are absent 14.7 days and children 9.7. The potential wages are, therefore, in each case higher than the figures quoted above, but, inasmuch as absenteeism seems to be a normal feature of the industry, they represent the actual amount of money on which a women or child subsists.

Information with regard to the wages paid in the jute mill industry is very scanty as no inquiry similar to that in Bomaby has been instituted by Government, though there can be no doubt as to its immense utility. As stated above, official statements regarding the periods of wage payment are available for Bengal. Unlike the cotton-mill industry wages in jute mills in Bengal are paid weekly, seven days in arrears. The only authoritative information in regard to the wages paid in the jute industry is to be found in the Annual Report of the Inspector of Factories for Bengal. In the Report for 1924 there is a small tabular statement according to which the minimum weekly wage for women piece-workers is Rs. 3.15 and for women preparers Rs. 2.8 while the maximum is Rs. 7.8 and Rs. 4 respectively. The maximum weekly wage for a child is stated to be Rs. 2.8 and the minimum Rs. 1.9. Dr. Curjel found that the average weekly wage of a women worker in a jute mill was Rs. 2.8 and that of a child Rs. 1.10.

The large proportion of immigrants among the textile factory population makes the question of housing both important and difficult in Bombay City as well as in the jute-mill area in Bengal. Bombay has for a long time been struggling with the housing problem ; it had considerable leeway to make up, as very bad conditions had been originally allowed to come into existence and owing to the City being on an island the area available was very restricted. At the 1921 census it was found that two-thirds of the population of Bombay were living in one-room tenements, the average number of occupants of each such tenement being more than four.

In 1920 a Development scheme was started which undertook to provide 50,000 one-room tenements. According to the latest report of the Development Directorate over 16,000 of these tenements had been completed by the end of March, 1925. Unfortunately, the high cost of erection, including the expenditure on roads, sewers and storm-drains, has made it difficult to obtain an economic rent for these dwellings, and it is understood that in consequence many of them are lying vacant. A City Improvement Trust has also been in operation and had completed over 31,000 new tenements during the period 1898-1925. The City Corporation has also a scheme for the provision of 8,000 tenements for their employees. A certain number of mills have also built dwellings for their workers.

In spite of all these efforts Bombay is not a healthy City, if the rate of infantile mortality can be taken as an index of its condition. In the year 1924-25 the infant mortality rate per one thousand registered births was 419. Dr. Sandilands gives reasons to show that this figure is not an accurate index of the real state of affairs, owing to the fact that there is a "wholesale immigration of babies into Bombay from elsewhere." His analysis of the rate of infant mortality according to the number of rooms occupied by a family indicates that no less than 63 per cent. of the total births took place in one-room tenements, and more than half of those born under such conditions did not survive.

The position of Bombay a few years ago was perhaps best described in the words of the Municipal Commissioner who stated in his report for 1920-21 that "in the congested areas of the City houses four and even five storeys high will be found attached on either side, and separated in the rear from a similar row of houses by a gully often less than six feet in width which takes the overflow from privies and affords access to the sweepers for the removal of the privy baskets."

The provision of housing for the jute mill employees is not quite as difficult as the Bombay housing problem. The jute mills are, for the most part, situated in a semi-rural area outside Calcutta along the banks of the Hooghly. In many cases the management have provided barrack-like dwellings for their labour, though I regret to say that it has not been possible for me to ascertain what proportion of labour has been housed in this way and what

proportion has been perforce compelled to live in mud hovels in the very insanitary villages surrounding the jute mills. The employers are not entirely to blame for this state of affairs. No sooner is a mill erected in a rural locality than the owners of the surrounding land, realising their opportunity, ask for prohibitive rents or prices for the area required for workmen's dwellings. Also, owing to the laws relating to inheritance and joint families, it is often difficult to obtain land with a clear title. Unless some form of compulsory acquisition is made possible in the case of land for industrial housing, the problem cannot be solved. Some system should be introduced which would enable and compel the local municipal authority to acquire land and provide suitable workmen's dwellings with necessary financial help or guarantee from the State and from the industry benefited.

The importance of providing satisfactory housing cannot be overrated as it has a very direct effect on the working population and specially on the women and children. Where the houses do not provide privacy for the women of the family, whether working in the factory or not, unsatisfactory moral conditions are bound to arise. Dr. Curjel has drawn attention to the instances of irregular family life which she met in the course of her investigation and has pointed out that the men were unwilling to bring their wives into surroundings where respectable women would not be willing to live. She found that "where there was evidence of a real family life among the workers usually the home was situated outside the mill in a bazaar or basti."

The conditions of employment in the coal mines and in the tea industry remain to be considered. The Indian Mines Act of 1923 which came into force on July 1st, 1924, definitely prohibits the employment below ground of children below the age of 13. It also gives power to the Government to promulgate executive orders prohibiting, restricting or regulating the underground employment of women. The question whether such prohibition should be enforced in the coal mines has been engaging the attention of the Government during the last three years. It is satisfactory to note that the Chief Inspector of Mines in his most recent report—that for 1924—states that the strenuous opposition in certain quarters to prohibition was showing signs of weakening. It is his opinion that "there would probably be less trouble now than at any time for many years in replacing women workers in mines." The Indian Mining Association, which represents European mine owners, has already approved in principle the gradual and ultimate elimination of female underground labour in mines.

Not only does the Mines Act of 1923 mark a very distinct step forward in relation to the employment of children, it has also, for the first time, definitely limited the hours of work in any one week consisting of six days to sixty for workers above ground and to fifty-four for underground workers.

With regard to the wages paid in the coalfields, not much detailed information is available. Some idea can, however, be obtained from the table

appended to the Report of the Chief Inspector. He found that underground miners in two large representative coalfields in Bengal were paid respectively Rs. 3 annas 6 for 42 hours worked and Rs. 4 annas 12 for 40 hours. Women in the same mines for 48 hours' work underground received Rs. 1 annas 14 and Rs. 2 annas 8 respectively. For work on the surface women were paid Rs. 1 annas 8 for 48 hours and Rs. 2 annas 7 for 60 hours' work.

Except in a few places mining is not the only occupation of the miner. The majority of the workers are agriculturists first and mining is regarded merely as a subsidiary occupation. Many of the miners live at a distance of many miles from the colliery in which they work and only come to work for a few days each week.

These facts make it difficult for colliery employers to provide amenities of life for the workers. In one of the mining settlements which I visited a very satisfactory labour colony had been established. The village was built in a fashion to which the inhabitants were accustomed. It is true that it mainly consisted of mud huts, but they were large and spacious and in each case clustered round a court-yard. The villagers had been given land to cultivate. Their attendance at the mine was good and it was evident that the village was regarded by them as their permanent home. In other places one found gloomy brick erections which looked like powder magazines. In many cases they were unoccupied. Fortunately, the problem of housing in the coalfields has been actively taken up. In both coalfields there is now a Mines Board of Health. In the Jharia coalfield the Board has prescribed stringent housing regulations. It is to be hoped that the wishes and peculiar ideas of the mining population have been considered, for obviously it will be useless to supply model sanitary dwellings which the miners will refuse to occupy.

Time does not permit me to deal at length with tea-garden labour. The kind of difficulties that arise in factory industries are largely absent in the case of teagardens, though these have their own peculiar problems. We have already seen that a very large proportion of the labour is imported. The cost of importation is very heavy and naturally the managers utilise all available methods to retain for some length of time the services of the men recruited. The Workman's Breach of Contract Act of 1859 made a defaulting workman who had accepted a monetary advance liable not only for civil damages, but to fine and imprisonment as for a criminal offence. It is satisfactory to note that in 1920 the Government of India considerably modified the law in favour of the workman and have now, as the result of popular pressure, repealed the Act.

To house the imported labour the Management have in some cases erected barrack-like structures, and in others provided the building material, leaving the workers free to build according to their own tastes. The latter method has proved the more satisfactory.

Dr. Curjel found that the average wage of a man worker in a Bengal tea garden was between Rs. 9 and Rs. 12, while a woman earned from Rs. 4 to Rs. 9 a month. Children earned according to their age and the kind of work they performed. She points out that in addition there were various perquisites. Free quarters are provided, and it is customary to allot land for cultivation. Some sort of medical relief is also given and in most gardens a system of maternity benefit is in force.

General Considerations.

A distinguishing feature of industrial labour in India is that the women employed are mostly married and frequently the mothers of young children. In England the majority of women industrial workers are between the ages of 18 and 24 and are unmarried. The effects of the employment of married women and young girls on the race are more potent than in the case of unmarried women. Another fact which should be borne in mind in considering the Indian situation is that a certain number of women workers are "unattached," that is to say, they are either widows or married women living apart from their husbands. Industrial women in India have not yet reached the stage when it is possible for them to live safely in isolation in this way. Dr. Curjel found that many of them had to seek refuge with men with whom they were not connected by any marital tie, and by whom they were deserted when the men returned home to their own villages.

The primary need of women workers is, therefore, the provision of suitable housing which will secure privacy and make happy family life possible. The position in this respect in Bombay and in the jute-mill areas has already been examined. Where the experiment has been tried of providing really suitable dwellings, as in Cawnpore and in Madras, it has proved a wonderful success. In Cawnpore there was one such settlement in charge of an American Missionary and his wife. They were able to do untold good. I also came across a mill near Calcutta where conditions were so satisfactory that it had been found possible to carry on almost entirely with local labour settled permanently near the mill.

As the majority of the workers, and specially the women, find it difficult to express their wants in this and other respects, it would pay the Management to have a special officer deputed to study and discover the real needs of the workpeople. In one colliery I came across a special official who had succeeded in recreating a village with all the joys of village life. One was greeted by a group of workers who came out and played their traditional music and performed their traditional dances which had been handed down from father to son. The contrast between this settlement and one in which the habits of the workers had not been studied would be evident to all.

Another need which arises directly out of the employment of married women is the provision of crèches. A beginning has been made and certain

mills have crèches which are satisfactory. But it is still not unusual to find small children taken into the factories. Where crèches are provided it is essential that a trained nurse should be employed, so that the children who are brought there do not suffer by coming in contact with children suffering from contagious diseases. It is satisfactory to note that, in Ahmedabad, where large numbers of women are employed, the provision of crèches is becoming more general. In the annual report for 1924 of the Textile Labour Unions of that town reference is made to the fact that ten mills provide comfortable crèches, while another ten have set apart space for cradles.

The provision of maternity benefits should follow as a natural corollary to the employment of married women in industry. At present there is no such provision in a great number of cases. From a recent bulletin published by the Department of Industries and Labour it appears that in the jute textile industries such provision is extremely rare. Mention is only made of three definite schemes, two of which have not been particularly successful. The third scheme which was largely worked out by Dr. Curjel has been very successful and may well be taken as an example by other firms in India. A well-equipped maternity and child welfare centre was established in the mill area with a qualified Supervisor in charge. Pre-natal and post-natal care is undertaken and the indigenous midwives are given opportunities for training. As a reason for the general lack of maternity benefits in the jute industry it is stated, on the authority of the Bengal Government, that " normal family life is notoriously absent among the labourers in jute mills. The peculiar type of the female labour in the jute mills does not conduce to the creation of schemes which pre-suppose normal family relations." This contention is supported by Dr. Curjel, who states that " the provision of maternity benefits among millworkers in Bengal owing to the non-stationary character of much of the labour and to the irregular lives led by many women workers, would not be easy of adjustment."

Particulars are given in the same Government report of about a dozen schemes in operation in the Bombay textile industry, but the number of women who have actually received benefits is comparatively small. The lack of success of some of these schemes seems to be due in most cases to the fact that either no qualified woman or no woman of the right type has been appointed to administer the scheme. In a certain number of mills the benefits are only pecuniary. Though pecuniary aid is necessary at such a time, the provision of skilled aid is even more necessary.

The present state of midwifery practice is extraordinarily bad in India. It is mainly a hereditary calling, to which are attached the worst possible traditions that one can imagine. Till within recent times the midwifery profession has only been practised by women belonging to very low castes and cleanliness is not one of their religious tenets as it is among the higher castes. There is, however, a brighter side to the picture. Efforts have

been made by successive Vicereines, to whom the suffering of the women and children has made special appeal, to improve this state of affairs. It is largely owing to their efforts that there exist in India a Women's Medical Service, a Women's Medical College, provision for the training of midwives, and to Lady Chelmsford is due the establishment of an all-India League for Maternity and Child Welfare, which has done incomparable good. The present Vicereine Lady Reading has aroused the interest of all India in the high rate of infantile mortality and has established on a permanent basis an all-India Baby Week to help to disseminate knowledge to combat this dreadful loss of life.

In the tea gardens of Bengal pecuniary help and some kind of medical aid is available. Dr. Curjel, however, found that "the doctors employed on tea estates rarely possess a registerable qualification, the salary offered being too low to attract better trained men." She found that "in many cases the hospitals were open wards, and there was no provision for the nursing and protection of women patients." She adds that though ante-natal and post-natal help is given, at the time of childbirth a woman has to depend on relatives or untrained midwives, who regard abnormal cases as foredoomed to die. She strongly recommends the employment of nurses and health visitors on tea estates. Maternity benefit is also given on Assam tea estates and there appears to be "increasing recognition of the value of liberal treatment."

In the coalfields of Bengal and Bihar maternity benefits seem generally to consist of the payment of small sums of money. The fact that the mining population frequently live at a long distance from their place of employment adds to the difficulties of the problem. The Asansol Mines Board of Health employs three trained midwives and this system is reported to have worked satisfactorily.

It will thus be seen that the question of the provision of maternity benefits is receiving attention in different parts of India. Valuable experience is thereby being gained as to the kind of schemes that are likely to be most successful. The question has also been raised from time to time in the Legislative Assembly and elsewhere.

Apart from skilled medical aid at the time of childbirth, women workers need medical supervision and aid throughout the time of their industrial employment. In certain factories there is a woman doctor on the staff who attends to women suffering from accidents, administers the maternity benefits and supervises the crèche. Unfortunately, such appointments are comparatively rare. Many factories have dispensaries and ambulance rooms, but such places are of comparatively little use to the women workers. The women are, in many instances, unwilling to avail themselves of the aid, because it is administered by men. Where large numbers of women are employed there should be a dispensary in charge of a qualified woman. If

a comprehensive measure could be framed making it compulsory in factories and mines employing a large number of women to provide them with suitable medical aid at the time of childbirth, as well as on other occasions and also making it obligatory to provide crèches, many of the ill effects arising out of the industrial employment of married women would be removed.

Many of the problems arising out of the employment of women and children cannot be dealt with satisfactorily until women are appointed on the Factory Inspection staff. In this respect a beginning has been made in Bombay. A woman factory inspector has been at work there for about a year. But no similar appointment seems to have been made in any other province, though large numbers of women and children are employed, especially in Bengal.

The history of the employment of women factory inspectors in England has proved clearly the benefits accruing from this measure, and one can only wonder with Viscount Cave why " the woman worker has so long been grudged the help. . . . which only a woman can give." There is even greater need in India for women factory inspectors for the women of India are in a far more helpless position. They are largely illiterate and in many cases are living away from their kith and kin in entirely strange surroundings. It is hard to see how they will be able to secure for themselves the full advantages of the legislation which has been passed in recent years unless there are some women inspectors. For instance, the recently enacted Workmen's Compensation Act applies to women and children equally with men, but as the women are often unwilling to use the existing dispensaries many accidents cannot fail to be overlooked. Women workers in India are even more unorganised than the men. They cannot, therefore, look to the Trade Unions except at Ahmedabad to help them to enforce their claims.

There is urgent need in India for what is commonly connoted by the term " Welfare Work." A certain amount of it is already being done in certain mills in India and by social agencies such as the Servants of India Society, the Young Men's Christian Association, the Seva Sedan and others. The Young Women's Christian Association also intend very shortly to take up this work and are sending out an expert to start it on right lines. There can be no doubt that welfare supervisors or employment superintendents are specially needed in factories where women and children are employed. There are many matters which need adjustment, if conditions are not to press too hardly on the workers. These adjustments can only be made by the factory staff. Unless there is a woman in a responsible position on the staff many of the grievances and difficulties of the workers never come to light. When they become intolerable the whole family simply leaves the factory. The labour turn-over in factories in India is very high, and if a welfare supervisor did nothing more than help to reduce this turn-over, her appointment would be an immense economic gain to the management.

Connected with the question of the need of employment superintendents

is the whole problem of the recruitment of factory labour. As has been seen, workers for Indian factories have frequently to be recruited from long distances. They come with very little knowledge of the conditions under which they will be expected to work; in a great many instances they work under the control of the man who has recruited them and are consequently almost entirely in his power. Bad enough as this is in the case of the men, it is very undesirable in the case of the women and children. Most factories cannot grapple with this immense problem single-handed. The establishment of Government labour exchanges may offer a solution.

Yet another point which should not be overlooked is the provision of facilities for recreation. There is special need for this in the case of half-timers who have ample leisure to profit by it. In some places there are good recreation grounds. It is not desirable that the employers should be asked to provide these facilities. It would be better if they were provided by Municipalities or Improvement Trusts. Employers might, however, be asked to contribute towards the cost of such schemes.

A still greater need is the provision of educational facilities for half-timers and adults. Primary education is making progress in India, but much of the good that is done in the schools is quickly undone when the children lapse back into illiteracy, frequently because their parents are illiterate. Schemes of adult education, on a large scale, can alone prevent this from happening. The majority of adult workers are at present illiterate, though many of them would be glad to know how to read and write. A beginning has been made in certain factory areas by Social Agencies and by certain large employers. The Compulsory Education Acts that have been passed in recent years apply, except in Madras and the Central Provinces, only to children below the age of factory employment. Measures are needed which will secure that children employed in factories shall have facilities to continue their education or to begin it if necessary.

Lack of funds and of trained teachers have long stood in the way of educational advancement, but inasmuch as employers of labour would quickly reap the advantage of an educated staff, there seems to be ground for hope that they would be willing to contribute towards the cost of such schemes. At present both employers and employed are hampered in their efforts to arrive at mutual understanding owing to the ignorance and illiteracy of the workers. The provision of education, apart from increasing general efficiency, should contribute very considerably to the smooth working of the factory.

This lack of elementary education is one of the chief difficulties with which Trade Union organisers have to contend in India. The Trade Union Movement is in its infancy in India, but it is interesting to note that the guiding spirit of some of the most successful Unions in Ahmedabad is a woman, Shrimati Anasuyaben Sarabhai, who is the President. These Unions have

just published their Annual Report. In 1925 they had a total membership of nearly 14,000, but it is not stated what proportion of these are women. They maintain a hospital, where special provision has been made for maternity cases. They also take up claims for compensation and administer the amounts awarded. In 1924 over 14,000 rupees were deposited with them and distributed by them in instalments. They deal with conditions of work and pay and also try to improve the conditions under which the workers have to live.

In conclusion, brief reference has to be made to some of the wider aspects of the employment of women in industry. The large numbers employed in Indian industries have already been mentioned. There can be little doubt that they are helping very considerably the industrial advancement and the material prosperity of the country. The demand for industrial labour in India has been, in the past, greater than the supply and unless women could also find employment even larger numbers of men would be unwilling to break up their family life to migrate into the cities. In view of the present low standard of the efficiency of the Indian worker and the fact that Indian industries have to compete in a world market, we cannot expect for some time to come that the earnings of the men only will keep a family, even according to the present low standard of comfort. The general exclusion of women from industrial employment, except, of course, in circumstances such as underground mining, where special considerations are involved, will inevitably lower the standard of life still further. The poverty of India is such that practically all women, excepting those belonging to the higher classes, are compelled to work. They are accustomed to agricultural work which, at certain times of the year, has to be done unremittingly. It is also arduous and exhausting. But such work is not always remunerative and the increasing use of agricultural machinery will gradually displace large numbers of women workers. An alternative occupation for them is highly desirable. On the other hand, in the general interests of the community and of the workers themselves it is essential that the conditions of the employment of women and children should be strictly regulated by law and practice and that there should be ample safeguards for the protection of their health and the maintenance of their moral ideals.

Satisfactory industrial conditions can, however, only be obtained, if there is a persistent and constant demand for them. This demand, in its turn, rests on an educated public opinion. It is for the men and women of India to see that the industries are built up on satisfactory foundations. They can only do this if they are prepared in the first instance to study existing conditions and to help to remedy the defects and drawbacks which exist. The women workers are at present in a more or less helpless condition. They depend on those who have better opportunities at the moment for bringing about reform, so that they shall not suffer in making their contribution to the industrial advancement of the country.

DISCUSSION.

THE CHAIRMAN felt sure that the audience had listened to the paper with the greatest interest. Personally she thought that Lady Chatterjee had approached the subject in a most sympathetic manner. From what she had said it could be gathered that she was fully aware of the difficulties and drawbacks which faced the women employed in industries in India ; but at the same time the paper was a very balanced one,—the author had not presented a very sad or terrible picture. She saw that industry, properly regulated, might be of very great value in India. It had to be remembered that women in industry numbered at the moment certainly under a million,—a very large number, but only a very small percentage of the 318 million inhabitants of India. It was necessary in such matters to keep proportions carefully in mind, and the fact that the women employed were a very small proportion of the population at the present moment was a very great advantage, because it seemed to her that the suggestions contained in the paper would be infinitely easier to carry out when dealing with industrial conditions in their infancy. After listening to the lecture she thought that India must accept the fact that labour for women and children had come to stay and all the influence possible should be used to ensure that that labour was well regulated and that good should come out of it both to employees and employers. If the great need of education was brought to the notice of the public in England and India, she thought those women and children would perhaps be the pioneers of a new movement. Women and children lived in India under the conditions of village life contented and happy and not seeking a new sphere of interest ; but when they came into touch with city life and met other people they began to realise that they were wanting in education. It was only when the villages asked for it and were determined to have it that really useful education would come into being in India. The great need was for welfare work of every sort and kind. She could imagine no more splendid work for educated women in India than to supply those two needs. The real reason why education had not progressed was that so far there were no large schools for training teachers. It was useless to talk of village schools until there was a large supply of teachers ready to man those schools. It was the same with welfare work ; what were required were welfare workers. The work which Lady Chatterjee had been able to start in India did aim at training welfare workers, and certain numbers of Indian women were trained to go and work under Ministries in any capacity, and she hoped that that movement might develop and be the beginning of a supply of welfare workers in factories. Dr. Curjel was one of the members of the Women's Medical Service in India and was a woman of great and wide sympathies. She was a Scandinavian, and she threw her whole heart into the work of education in India and had been a most valuable servant of the Indian Government.

She would not take up time by discussing the many interesting questions which Lady Chatterjee had dealt with in her paper, except to make the suggestion that if only Bombay would move its factories and its factory population out of Bombay, instead of trying to make more room for them in Bombay, it would be one of the things that would help to solve their problems.

MISS ROSE SQUIRE (one of the first women factory inspectors in Great Britain) thought the Society was very much indebted to Lady Chatterjee for the extremely interesting address she had given, and many must feel, as she did, that the address was a comprehensive study of the position in India with regard to women and children in industry such as had never been quite approached before. The point that struck her was that Lady Chatterjee had shown very clearly the need for

women's work in the interests of women and children employed in industry in India. The case she had put forward for India very closely resembled the case that was put before this country about thirty years ago. Under the Factory Acts a good inspectorate, well-qualified, was established but that inspectorate consisted of men who had to deal with large numbers of women and children employed in factories. Then an agitation was commenced for women to be employed in the inspectorate, and such appointments took place in 1893. As one of the first in that group of women to be appointed as factory inspectors, she could bear testimony to the effect of their presence among the women and children in the factories.

She should like to refer to what was said quite recently, in the House of Commons, in 1921, by Lord Oxford and Asquith. He referred to his responsibility for that "terrible innovation of women as factory inspectors," and he said, "We have not gone back upon it; on the contrary it has been developed on an ever-increasing scale and all must admit that it has had most beneficial results with regard to the women and girls in our factories and workshops." Not only did that result follow in enforcing the law—and she thought everyone would agree that however good our laws were, unless they were enforced they might just as well not be on the Statute Book—but by investigating the conditions they were able to inform the Government as to the needs for further legislation. The women factory inspectors in those early days were almost mobbed when they went into factories by the women, who left their machines and came to tell their grievances. The employers in almost every case welcomed the women inspectors. The only complaint was why they had not had women inspectors before. When the women were too shy to come to the inspectors the inspectors went to them, as they had the right to do, and they gradually built up a body of information from the women themselves as to where the shoe pinched and what was necessary. The further legislation which followed had largely come from the information received from the women. Since those days, whenever any legislation had been passed or regulations made affecting women or children, women factory inspectors had been set to work to investigate and had been consulted all through with regard to any necessary amendments of the law. The employment of women as factory inspectors needed to be reinforced and supplemented by the employment of women as welfare supervisors in the factories themselves. In those early days they were frequently met by the employer with the remark, "Where can I find a woman like yourself to come into the factory and advise me and look after the welfare of the women here?" The term "welfare supervisor" did not follow for some years after, but gradually the thing itself came into being, and now all really well-regulated factories had on the staff an educated, sympathetic, intelligent woman who was in charge of the welfare department. Lady Chatterjee and herself were associated during the war at the Ministry of Munitions and part of their work there was to see that welfare supervisors were employed to look after the women employed, and were properly trained for their work. Only the previous week she had been in a factory where the number of young people employed had very much increased, and now there were not only one chief supervisor, but fourteen assistant welfare supervisors on the staff. The employer had found that not only had the improvements which were considered necessary been carried out to the great satisfaction of himself and the women, but also, as Lady Chatterjee had mentioned, that the numbers leaving, which was often very high in factories, had steadily decreased since the welfare supervisors had been in touch with the women and children and had been able to investigate the causes of frequent leaving. The health of the women and girls in that factory had

very much improved. Not only were there welfare supervisors, but also a medical woman who visited every week and everybody engaged was examined by her.

SIR PURSHOTAMDAS THAKURDAS, C.I.E., M.B.E., M.L.A., said he was sure everyone would agree with him that Lady Chatterjee had given the survey in a manner which had been correctly described by Lady Chelmsford as extremely well-balanced. It was a matter for congratulation that the case for the women workers of India should be put forward by a lady so well acquainted with Indian conditions and possessing such wide sympathies with the women of India. There was no exaggeration in her address, and Lady Chatterjee had been able to compress a considerable number of facts and figures into the shortest space possible. He congratulated her on the able and full manner in which she had put forward the case of the women workers in India.

He only wished to refer to one or two aspects. Lady Chatterjee had referred to the very poor housing accommodation in Bombay for the women workers, and that fact was absolutely correct. It was the misfortune of Bombay city and all those who had industries in that city that the Development Department which was established for the betterment of the housing of the workers in Bombay should have proved what it now appeared to be. The main interest of Bombay was the extension of the city on the north in the shape of single-storied premises on land which was awaiting development. Although that was part of the scheme of the Development Department, unfortunately the major amount of money up to the present had been spent on what had been known as the Back Bay reclamation. A number of tenements, about 16,000, had been put up. In spite of the trade depression that set in since building work was started, the houses had been more expensive than was estimated, and many of the one-room tenements had practically been vacant. He was sure Sir Leslie Wilson, the Governor of Bombay, would try to maintain this very useful activity of the Department, namely, the provision of cheap tenements in the north of Bombay, instead of the reclamation of Back Bay. The poor housing accommodation was largely responsible for the high rate of infant mortality in Bombay, but it might be some compensation to know that the greatest of the benefactors of the women workers in that connection had been a very prominent industrialist in Bombay, Mr. Wadia, who only last year gave a donation of 16 lakhs of rupees for establishing a lying-in hospital for the working women of Bombay in that part of Bombay where the mills were situated. That hospital, which had been carried on by Mr. Wadia now for two years at his own expense, had been an entire success. The doctor in charge of the hospital was an intimate friend of his, and he was convinced that the hospital was doing splendid work. After being satisfied of the value of the work, Mr. Wadia gave a princely donation, which was accepted by the Government of Bombay, and all the arrangements for the carrying on of the hospital had now been made. It might therefore be stated that the person who first recognised the interests of women in the work of Bombay was a great industrialist of the City.

He would like to ask whether, in furtherance of the efforts which were being made to provide happy homes for Indian workers, greater and more strict control of the sale of alcohol in industrial centres should not be taken in hand? The Government would do well to turn their attention to it. It was, he believed, only because of Lady Chatterjee's anxiety not to take up more time that she did not refer to it in her paper. He ventured to suggest that that should be a direction in which the attention of the Government and the legislature should be constantly drawn. Nobody could overlook the fact that liquor was bound to make the homes

of all concerned in those places very unhappy, and where men and women had both to work the greatest blessing that could be devised for them would be to keep them away from liquor.

COLONEL SIR CHARLES YATE, BT., C.S.I., C.M.G., said he had listened with interest to what the last speaker had said about the results of housing in Bombay. The houses erected by the Government on the site mentioned were said to be so expensive that they could not be occupied by the workmen and many of them had remained empty till now. In that connection he hoped Sir Purshotamdas Thakurdas would write a letter to *The Times* and let the people of this country know what the results of the experience in Bombay had been in building houses that could not be let at an economic rent, the rent being too high for the ordinary workman to pay. He thought it would be of considerable benefit to Municipal Authorities in this country to know that cheap cottages were what was required by the working man, not expensive houses.

SIR CHARLES E. LOW, K.C.I.E., said it had been a great pleasure to him to listen to the very interesting and very excellent paper read by Lady Chatterjee, his old friend and colleague in the Central Provinces and in the Government of India. The work to which her paper related started after the war when Governments and other people in India had begun to be influenced by modern ideas on these questions and especially by the movement initiated by the League of Nations in connection with labour. There was no one better equipped for the task than Lady Chatterjee. The experience of an inspectress of schools in the Central Provinces, with long journeys and camp life, was very unpleasant and often an uncomfortable existence for a woman, but it gave her a thorough insight into Indian village life and conditions, and as it was from the Indian village that Indian factory labour was drawn, such knowledge and understanding was absolutely necessary for anyone who wished to realise the problems of Indian factory labour, especially in regard to the labour of women. Lady Chatterjee was not really keen on inspecting schools and always had a great desire to take up just such work as eventually fell to her lot. She was always anxious to do social work that would benefit the people of India rather than to look after very bad, very scanty and rather inefficient schools. After that, she came back to England and got into touch with all the latest developments in the way of factory welfare during the war, and going out to India she joined the Industries Department with the greatest enthusiasm to review the whole position of women factory workers all over India. The series of investigations she made enabled her to see the position as a whole. Isolated attempts had frequently been made before in various parts of India, but no one previously had ever considered the question from the all-India point of view. That course involved the use of a great many statistics, very troublesome to collect with accuracy and not always easy to digest. He had noted that Lady Chatterjee always illuminated her statistics with a great deal of human sympathy and with a sense of the ultimate importance to the country of dealing with the conditions in factories generally. The Indian village was a very curious institution. It was almost impossible to destroy it. Devastations and war had done their work, and after a hundred years the Indian village was still standing. At the same time it was most difficult to create. To create Indian village conditions for Indian factory workers was the idea of the best and highest-minded employers, and Lady Chatterjee had given one or two instances where the work had been done absolutely successfully. All who were interested in the question of Indian factory labour would take those remarks to heart and remember

that if they wished to have contented and efficient factory labour, it was necessary as far as possible to try and reproduce something like the village conditions to which the labourers were accustomed and under which they would live happily.

SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., LL.D., F.R.S., (Chairman of the Council) said that on behalf of his colleagues on the Council of the Society he wished to convey to Lady Chelmsford their sincere thanks for presiding that afternoon and to Lady Chatterjee for her admirable paper. He should like to propose a very hearty vote of thanks to both.

Lady Chelmsford had shown a great interest in the welfare of women and children in India during the term of office of Lord Chelmsford as Viceroy, and she still maintained that interest. That interest was not one of mere sympathy, but was based on actual investigation of the facts. He felt responsible for the paper in more senses than one. As Chairman of the Council of the Society he instigated Lady Chatterjee to prepare a paper describing her experience of Indian factory conditions, and that feeling of responsibility had now given place to one of real satisfaction. The responsibility went still further back, for in 1919, when he was asked to return to India to organise a department of labour, one of the questions which he knew had to be faced was that of the employment of women and children in the factory. The Industrial Commission had seen something of labour conditions, but they could only look at those conditions as men. They knew perfectly well that there were things to be learned of the conditions of labour of women and children which particularly had to be dealt with, and he wished to secure the necessary data on which they could work. They were legislating in the dark. He went back to India in 1919 with the intention of creating a position in which could be employed the one person he had found who obviously had the necessary qualifications. Lady Chatterjee had distinguished herself in welfare work during the war and she had knowledge of India and was experienced in the language, and she agreed, with enthusiasm, to go back and take on the work. The result of her survey was published in book form in 1924, as well as in Official Reports. That book was well worthy of study by anyone who wished to follow up the question and it was in recognition of the value of that Report that the University of London decided to confer upon Miss Broughton, as Lady Chatterjee then was, the degree of Doctor of Science. Now, Dr. Broughton, in quite a different capacity, was able to carry on her work as Lady Chatterjee.

He had very great pleasure, on behalf of the Council, in conveying thanks to both Lady Chelmsford and Lady Chatterjee for the way in which the meeting had been conducted and for the extraordinarily fine paper that had been read that evening.

The motion was carried with acclamation.

OBITUARY.

JOSEPH PENNELL.—The Society has lost a very distinguished Fellow by the death of Mr. Joseph Pennell, which took place from pneumonia, in his home at Brooklyn, at the age of 66.

Born at Philadelphia in 1860, he was educated at the Friends' Select School, Germanstown, and whilst still a lad entered the employment of the Philadelphia and Reading Coal and Iron Company, at the same time attending the School of Industrial Art, Philadelphia, and subsequently the Pennsylvania Academy of

Fine Arts. After doing some drawings for *Harper's* and other magazines he was commissioned by the *Century* to go to Europe and make etchings for a series of articles on Tuscany. He came to London in 1885 and finally settled in the Adelphi, where his flat, commanding an unrivalled view over the Thames and London, soon became a meeting ground for all that was most interesting in art and literature. He was appointed art critic of the *Star*, where he numbered among his colleagues Mr. G. B. Shaw, Mr. A. B. Walkley, and Mr. Richard Le Gallienne; and he was also for a time art editor of the *Daily Chronicle*.

Pennell was a magnificent craftsman, and this, combined with amazing energy, enabled him to produce an enormous number of drawings and prints of great excellence. Much of his work was done as illustrations to the travel books which were admirably written by his wife. His own writings on the various arts of which he himself was a master are very valuable. They include such works as "Pen Drawing and Pen Draughtsmen," 1889; "Modern Illustration," 1895; "Lithography and Lithographers," 1900; "Etchers and Etching," 1919; and "The Graphic Arts," 1922.

In later years Pennell devoted a great deal of time to illustrating what he called "The Wonder of Work." Of this his Panama lithographs are perhaps the best known. He travelled fifteen thousand miles to undertake this task, and his illustrations of great excavations, giant steam shovels, piers, girders, scaffolding and so forth, give a wonderful impression of a titanic task.

Pennell joined the Royal Society of Arts in 1885 and for many years took a warm interest in its work, frequently presiding at meetings and speaking in the discussions. He read papers on "English Book Illustration," in 1896; "Senefelder and the Centenary of Lithography," in 1898; and "The Pictorial Possibilities of Work," in 1912, for the last of which he received the Society's silver medal. He also delivered a course of Cantor Lectures on "Artistic Lithography," in 1914, and these formed the basis of the technical portion of his "Etchers and Etchings," a delightful and most attractively illustrated work which has just reached its third edition. Nor must we forget a paper of a very different kind which he read here in 1901, entitled "Some Experiences of Motor Bicycles." Pennell loved to be in the van of progress, and he was among the earliest to ride, first, the old "ordinary" or high bicycle, and then the motor bicycle. The account which he gave of his travels on his "Werner" and the difficulties he had in getting repairs effected, still makes a most entertaining paper.

Professor Lilian C. A. Knowles, M.A., Litt.D., LL.M.—Mrs. Lilian Knowles, Professor of Economic History in the University of London, died on April 25th after an operation.

She was educated at Girton College, Cambridge, where she took first classes in the Historical Tripos in 1893 and in Part I of the Law Tripos in 1894. In 1896 she was awarded a research studentship in the then recently established London School of Economics, and in 1904 she returned to the School as Lecturer in Modern Economic History, subsequently becoming Reader, and finally Professor, of Economic History in the University of London. From 1920 to 1924 she was also Dean of the Faculty of Economics in the University of London, being the first woman to hold such an office.

The subject which Professor Knowles made particularly her own was the economic history of Great Britain and the Empire, and she was the author of two works which are to day recognised as standard text-books—"The Industrial and Commercial Revolutions in Great Britain" and "The Economic Development of the Overseas

Empire, 1763-1914." She served on the Departmental Committee on the rise of the cost of living to the working classes in 1918, and on the Royal Commission on the income tax, from 1919-20. In addition to the vast knowledge which she possessed, both geographical, historical and economic, she was a brilliant lecturer and she roused great enthusiasm amongst her students.

Professor Knowles was elected a Fellow of the Royal Society of Arts last year.

HENRY WAGNER, M.A., F.S.A.—Mr. Henry Wagner, who was elected a Life Member of the Society in 1874, died at Brighton on April 24th at the age of 85. He was educated at Rugby and Merton College, Oxford, and was called to the Bar by the Inner Temple, but never practised. He became secretary to his old friend, the Baroness Burdett-Coutts, and subsequently to Sir James Brooke, Rajah of Sarawak. In 1867 he was appointed a director of the French Hospital, and from this time he devoted a great deal of attention to research into the genealogies of the Huguenot families—a subject on which he became a recognised authority. He was also a keen collector of *objets d'art*, and a short time ago he presented some fine Italian primitives to the National Gallery.

For many years he was a most generous worker in charitable causes, and he spent a large portion of his income on hospitals and private benefactions.

NOTES ON BOOKS.

ETCHERS AND ETCHING. By Joseph Pennell. London: T. Fisher Unwin, Ltd. 42*s* net.

It is a great pleasure to learn that a third edition of this magnificent book has been called for within eight or nine months after the publication of the second; and this fact would seem to indicate that there are still a good many people in the world capable of appreciating great etching when they see it, *pace* the author's bitter denunciations of critics, curators, collectors, amateurs, *et hoc genus omne*.

An interesting point about this edition is the inclusion of two etchings by Legros—the *Portrait of Dalou* and the *Promenade du Convalescent*. Mr. Pennell states that it is only within the last months that he has come across some interesting plates of his, and his appreciation of these is a generous tribute to the artist, though no doubt much of his work was such as to justify the severe strictures passed upon him in other parts of this book.

The lover of etching can hardly be too grateful for this book, for it contains all that is greatest in the art, and this beautifully reproduced. Thus we have the masterpieces of Rembrandt, Van Dyck, Whistler, Dürer, Meryon, Strang, and others, together with a number of extremely fine works by the author himself.

The second part of the book, which deals very fully with the technique of etching, will be particularly welcome to students. It is founded to a large extent on the course of Cantor Lectures which Mr. Pennell delivered before the Royal Society of Arts in 1914; but as he is always learning, the book naturally contains a great deal that the lectures did not. He is a most diligent student of everything pertaining to the various processes which he describes, and he is the last man in the world to keep to himself any information that may tend to the advance of the arts which he himself practises with such conspicuous success.

(P.S.—Since this notice was written information has been received of the death of Mr. Pennell. An obituary notice of him appears in this issue of the *Journal*.—Ed.)

THE CHARM OF INDIAN ART. By W. E. Gladstone Solomon. London: T. Fisher Unwin, Ltd. 10s. 6d. net.

Mr. Solomon, who is Principal of the Sir J. J. School of Art and Curator of the Art Section of the Prince of Wales Museum in Bombay, should be in a favourable position to estimate the vitality and inspiration of modern Indian Art. He takes us back to the India of olden times and fairy tales, which was created so vividly and charmingly for us by Mr. F. W. Bain in his " Digit of the Moon," " A Draught of the Blue " and the remainder of his series of Indian love stories, and would have us believe that the romance and charm of those ancient days is still a very living thing in the India of to-day. His attitude towards feminine beauty, especially in the chapter on the Women of the Ajanta caves, as the incarnation and symbol of an ideal spiritual beauty, is very reminiscent of the *leitmotif* of Mr. Bain's books. A portion of the book is devoted to an account of the small Prabhu caste in Bombay, whose members, Mr. Solomon tells us, in their daily lives and in connection with their religious observances hand on the sacred torch of Art. The author's main conclusion is contained in the following quotation: " Stirred by a national spirit the old artistic Genius of the country is beginning its new ' Avatâra '; and both Eastern and Western observers are welcoming the wonderful Renaissance that has begun as a new impetus for Art. The stable artistic traditions of India cannot but prove invaluable to a world that has committed the Image of Art to the melting-pot. Shall that Image finally emerge from the ordeal, fearful in form as the monster of Frankenstein, or adorable as the goddess Shree ? "

THE NOMENCLATURE OF THE BANDED CONSTITUENTS OF COAL.

By CLARENCE A. SEYLER. B.Sc., F.I.C.

In view of the wide acceptance in Great Britain of the terms vitrain, clarain, durain, and fusain, devised by Dr. Stopes to describe the banded constituents of British bituminous coal, and the introduction of the further terms anthraxylon and attritus by Dr. R. Thiessen, it may be of interest to define the relation between them. At a recent symposium of the Coal Research Club, at which both Dr. Stopes and Dr. Thiessen were present, it appeared to be agreed that the two systems have entirely different bases and that each has its validity and use. It was the important service of Dr. Stopes (Proc. Roy. Soc. 1919) to replace the vague terms bright and dull coal by others capable of exact definition. The basis of her system is a lithological one. There are two kinds of bright coal. Vitrain is not in itself banded, and has a glassy lustre and conchoidal fracture. Clarain is banded or striated, and consequently scatters light, and has a silky lustre and does not break with a conchoidal fracture. These purely lithological characters are sufficient to define the terms, without resort to the microscope, a feature essential for practical purposes to retain. Dr. Stopes correlated them with the microscopic and chemical characters, but these are under further investigation. Clarain, whether derived from a single plant fragment or from general debris, always shows marked structure in thin sections. In vitrain the structure, even if not entirely absent, is relatively obscured or obliterated, so that it produces no striation or scattering of light at the surface. Dr. Thiessen's

terms, on the other hand, have a botanical, not a lithological basis. It is the contention, first advanced by White and Thiessen in 1913, that the bright laminæ of coal (which from their description must have been vitrain) are always derived from parts of stems and roots. This material Dr. Thiessen calls anthraxylon. The term suggests "coal derived from wood."

Dr. Thiessen perhaps underestimated the contribution of cortical tissues to coal. Miss M. Evans, at the University of Sheffield, has found much vitrain to consist of periderm, and I have under investigation a thick band of clarain consisting wholly of the periderm of a Sigillaria or Lepidodendron. Nevertheless, it is clear that Dr. Thiessen includes in anthraxylon all the associated tissues of stems and roots. His generalisation may be expressed in the statement "all vitrain is anthraxylon." The converse is not true, all anthraxylon is not vitrain, it may be clarain or even fusain, which Dr. Thiessen describes as "carbonised anthraxylon." Nothing could better illustrate the difference between the two systems of nomenclature.

In striking contrast to anthraxylon is the general plant debris, called by Dr. Thiessen attritus. The essential point is that whereas anthraxylon is of homogeneous botanical origin in stems and roots, attritus is of heterogeneous origin in plant debris of all kinds. It is a sort of concrete in which larger fragments (anthraxylon, spore-exines, cuticles, etc.) are embedded in a cement of finely comminuted debris. If the brighter components preponderate it will be clarain, if the duller ones, it will be durain.

The relation between the two systems may be tabulated as follows :—

A. ANTHRAXYLON (of homogeneous botanical origin from stems or roots).	A_1 Structure absent, obscured or faint.	Lustre glassy, fracture conchoidal or semi-conchoidal, not laminated.	VITRAIN
	A_2 Structure well preserved.	A_2 I. Dull, friable.	FUSAIN
		A_2 II. Lustre silky, minutely laminated	CLARAIN
B. ATTRITUS (of heterogeneous botanical origin, general plant debris).	B_1 Much anthraxylon present.	Lustre silky, minutely laminated	CLARAIN
	B_2 Little anthraxylon present.	Dull, compact.	DURAIN

Should it prove that there is a vitrain not derived immediately from portions of stems or roots, this will simply mean that there is a kind of vitrain not contemplated by Dr. Thiessen. The two kinds of clarain could be distinguished as anthraxylous and attrital clarain respectively. Dr. Thiessen uses the adjective "attritious," but I do not think it happily formed, and consider "attrital" on the model of detrital, to be better.

ALFA AND PALM FIBRE IN ALGERIA.

Alfa, or esparto grass, is by far the most important of the fibrous plants which grow in Algeria, and an important quantity of this grass is shipped annually to the United Kingdom, where it is absorbed by the paper factories, mainly in Scotland, in the manufacture of high-grade paper for printing purposes.

The Algerian alfa-bearing lands total 3,976,307 hectares (1 hectare=2.47 acres), of which about 777,000 hectares are situated in wooded areas.

The following table taken from the Report on Commercial conditions in Algeria by H.M. Consul-General at Algiers is of interest, as it shows the distribution throughout the whole of Algeria of the regions where alfa flourishes :—

——	Northern Algeria.			Southern Terri-tories.	Total.
	Dept. of Algiers.	Dept. of Oran.	Dept. of Constan-tine.		
	Hectares.	Hectares.	Hectares.	Hectares.	Hectares.
Land not in forest areas ..	306,490	826,361	292,686	1,773,000	3,198,537
Land in forest areas ..	10,373	467,820	297,430	2,147	777,770
Total ..	316,863	1,294,181	590,116	1,775,147	3,976,307

Alfa exports during the five years 1920-24 were as follows :—53,982 tons in 1920; 37,169 tons in 1921; 104,965 tons in 1922; 109,231 tons in 1923; and 117,400 tons in 1924. Of this last figure 105,002 tons were exported to the United Kingdom. The value of the total shipments in 1924 amounted to Frs. 35,220,000.

Although Algeria is capable of producing a far greater quantity of alfa than is indicated by the figures set out above, the quantity actually harvested is limited, owing to the lack of transport in many districts, the insufficiency of labour and inadequate storage accommodation.

Palm fibre (*crin végétal*).—The manufacture of vegetable fibre, or *crin végétal* as it is locally called, from the leaf of the dwarf palm, is an industry which has recently produced very good results in Algeria. As a rule, reports H.M. Consul-General at Algiers, it has been the custom for the factories engaged in this industry to work at low pressure during the summer and winter months, but throughout 1924 the maximum production was maintained at all the plants.

Crin végétal is superior to animal hair insomuch that it is vermin proof, and mattresses stuffed with this fibre last indefinitely. Besides bedding, vegetable fibre is used to a considerable extent by upholsterers.

During the year 1924 there was a noticeable expansion of the continental demand, and the requirements of the Central European countries have multiplied so considerably that the Algerian production is practically absorbed before it becomes available. The quantity exported in 1924 was a little over 58,000 tons, valued at Frs. 25,673,000, as compared with 40,000 tons in the preceding year.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MAY 10. . Geographical Society, at 135, New Bond Street, W. 8.30 p.m. The Right Hon. Earl Cawdor, "The People of the Tsangpo Gorge."

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m.

University of London, at King's College, Strand, W.C. 5.30 p.m. Le Père Delehaye, "l'Histoire du Culte des Saints dans l'Antiquité." (In French). (Lecture I.)
5.30 p.m. Mr. Henry Wickham Steed. "Central Europe and the Peace." (Lecture I).
5.30 p.m. Baron A. F. Meyendorff, "Russian Thoughts on Problems of Ethics." (Lecture II).
5.30 p.m. Dr. Otaker Vocadlo, "The Place of the Czechs in the Slavonic Family." (Lecture II).
5.30 p.m. Dr. Hubert Hall, "Some Aspects of Diplomatic Study." (Lecture I).
At University College, Gower Street, W.C. 5 p.m. Prof. G. Dawes Hicks, "Hegel's Aesthetics." (Lecture II).
5 p.m. Prof. A. F. Pollard, "Modern English Historians: (II) Froude."
5.30 p.m. Prof. Dr. J. B. Collingwood, "The Influence of Water on Vital Processes." (Lecture V).
At the Imperial College, Royal School of Mines, South Kensington, S.W. 5.15 p.m. Prof. Sir T. W. Edgeworth David, "Past Ice Ages of the World, and their Control of Animal and Plant Life, with special reference to the Australian Evidence." (Lecture II).

TUESDAY, MAY 11. . Aeronautical Engineers, Institution of, at 39, Victoria Street, S.W. 6.30 p.m. Captain W. H. Sayers, "The Modern Theory of Aerofoils and its Application to Aeroplane Design."

Colonial Institute, at Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m.

Marine Engineers, Institute of, 85-88 The Minories, E. 6.30 p.m. Mr. W. J. Guthrie, "Some Notes on Reduction Gear."

Quekett Microscopical Club, 11, Chandos Street, Cavendish Square, W. 7.30 p.m. Messrs. E. Heron Allen and A. Earland "Selective Building in the Shells of the Foraminifera."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. G. W. C. Kaye, "The Acoustics of Public Buildings."

University of London, at King's College, Strand, W.C. 4.30 p.m. Prof. Dr. R. J. S. McDowall, "The Integration of the Circulation." (Lecture III).
5.30 p.m. Mr. A. M. Henderson, "Russian Musical Art."
At University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. G. E. Moore, "Universals and Particulars." (Lecture II).

WEDNESDAY, MAY 12. . British Academy, at King's College, Strand, W.C. 5.15 p.m. Monsieur Emile Légouis "The Bacchic Element in Shakespeare's Plays."

Eugenics Education Society, at Burlington House, W. 8.30 p.m. Mr. W. T. J. Gun, "Some Aspects of Hereditary Ability."

University of London, at University College, Gower Street W.C. 5.30 p.m. Prof. Didrik Arup Seip, "Norwegian, a Language in the Making." (Lecture II).
At the London School of Economics, Aldwych, W.C. 5.30 p.m. Prof. P. J. Noel Baker, "Practical Problems of Disarmament. Lecture III—Land Disarmament."
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. The Rev. Arthur S. Cripps, "The Wanjanja, Wanhera and Neighbouring Tribes." (Lecture II).

THURSDAY, MAY 13. . Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Faraday Society, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 2.30 p.m. and 7.45 p.m. Part I.—Explosive Reactions Considered Generally. 1. Dr. W. E. Garner: Introductory Survey. 2. Professor H. B. Dixon, J. Harwood and W. F. Higgins: "On the Ignition Point of Gases." 3. Professor W. T. David, "Radiation in Gaseous Explosions." 4. (1) Dr. S. W. Saunders and Dr. W. E. Garner, "Ionisation in Gas Explosions." (2) Communication from Dr. S. C. Lind, "Ionisation and Gas Explosions." 5. Professor R. V. Wheeler and Dr. W. Payman, "The Uniform Movement of Flame." 6. Professor W. A. Bone, F.R.S., "Explosions at High Pressure." 7. Dr. Colin Campbell and Professor H. B. Dixon, "Explosion Wave in Cyanogen Mixtures." Part II.—Explosive Reactions Considered in Reference to Internal Combustion Engines. 8. Sir Dugald Clerk, "Introductory Survey." 9. Professor W. T. David, M.Inst.C.E., "Combustion in Gas Engines." 10. H. T. Tizard, "Explosions in Petrol Engines."

Historical Society, 22, Russell Square, W.C. Mr. E. F. Jacob, "The Reign of Henry III.—Some Suggestions."

Optical Society, at the Imperial College of Science, South Kensington, S.W. 7.30 p.m.

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. Annual General Meeting.

Royal Society, Burlington House, W. 4.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir W. Bragg, "The Imperfect Crystallisation of Common Things." (Lecture III).

Transport, Institute of, at Birmingham. Annual Congress.

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Edgar Prestage, "Almeida-Garrett as a Dramatist."
5.30 p.m. Le Père Delehaye, "l'Histoire du Culte des Saints dans l'Antiquité." (In French). (Lecture II).
At University College, Gower Street, W.C. 2.30 p.m. Prof. Sir Flinders Petrie, "Recent Discoveries in Egypt."
5.30 p.m. Dr. C. Pellizzi, "Francesco De Sanctis." (In Italian).
At the London School of Economics, Aldwych, W.C. 5 p.m. Mr. D. H. Robertson, "Projects of Monetary Reform." (Lecture II).

FRIDAY, MAY 14. . Astronomical Society, Burlington House, W. 5 p.m.

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. L. Smith, "Notes on Static Transformer Testing."

Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Mr. Seton Gordon, "The Golden Eagle."

Transport, Institute of, at Birmingham. Annual Congress.

University of London, at King's College, Strand, W.C. 5.30 p.m. Professor Dr. J. Kay Jamieson, "The Nature and Functions of the Fasciae of the Human Body." (Lecture III).
At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. E. Beddington Behrens, "International Problems of Industry." (Lecture III).

SATURDAY, MAY 15. . Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. G. C. Simpson, "Atmospheric Electricity."

Transport, Institute of, at Birmingham. Annual Congress.

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FRIDAY, MAY 14th, 1926.

All communications for the Society should be addressed to the Secretary, John Street. Adelphi, W.C. (2.)

NOTICES.

POSTPONEMENT OF MEETING.

The Paper on "Industrial Welfare in Practice" by MR. WARRE S. BRADLEY, which had been arranged for Wednesday evening, May 12th, has been postponed owing to the strike.

DOMINIONS AND COLONIES SECTION.

TUESDAY, MAY 4th, 1926. BRIGADIER-GENERAL SIR S. H. WILSON, K.C.M.G., K.B.E., C.B., Permanent Under-Secretary for the Colonies, in the Chair.

A paper on "Nyasaland" was read by MR. CHARLES PONSONBY, Managing Director, British Central Africa Company.

The paper and discussion will be published in the *Journal* dated June 11th.

EIGHTEENTH ORDINARY MEETING.

WEDNESDAY, MAY 5th, 1926. PROFESSOR WILLIAM HENRY ECCLES, D.Sc., F.R.S., in the Chair.

The following candidates were proposed for election as Fellows of the Society:—

McKay, William, Honolulu, Hawaii.
Pakenham-Walsh, Ernest, I.C.S., Guntur, Madras, India.
Wilson, Andrew, Sydney, N.S.W., Australia.

The following candidates were duly elected Fellows of the Society:—

Aiken, Frank Jay, New Orleans, U.S.A.
Fishenden, Mrs. Margaret, D.Sc., London.
Hendrie, George A., Niagara Falls, New York, U.S.A.
Maggs, Miss Lucy Agnes, Bath.
Weigall, Lieut.-Colonel Sir Archibald, K.C.M.G., London.

A paper on "Radio: its Past, Present, and Future," was read by MR. C. F. ELWELL, M.I.E.E., F.Inst.R.E.

The paper and discussion will be published in the *Journal* dated June 18th.

SPECIAL MEETING.

THURSDAY, MAY 6th, 1926. SIR CHARLES C. WAKEFIELD, BT., C.B.E., LL.D., in the chair.

A paper on "The Preseivation of Ancient Cottages," was read by SIR FRANK BAINES, C.V.O., C.B.E., F.R.I.B.A.

The paper and discussion will be published in the *Journal* dated June 25th.

INDIAN SECTION.

FRIDAY, MAY 7th, 1926. THE RIGHT HON. LORD HARDINGE OF PENSHURST, K.G., G.C.B., G.C.S.I., G.C.M.G., G.C.I.E., K.C.V.O., in the chair.

A paper on "The New Delhi" was read by MR. HERBERT BAKER, A.R.A., F.R.I.B.A.

The paper and discussion will be published in the *Journal* dated July 2nd.

PROCEEDINGS OF THE SOCIETY,

FIFTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 14TH, 1926.

SIR FRANK WARNER, K.B.E., in the Chair.

THE CHAIRMAN, in calling upon the author to read his Paper, "Art Training for Industry and the Society's Competitions," reminded the meeting that the Royal Society of Arts was founded for the encouragement of the arts, manufactures, and commerce of the country. It followed, therefore, that a Paper on such a subject was always welcome. Mr. Dawson would speak on the Industrial Designs Competition Scheme which the Society organized two years ago, with great promise of success.

The following paper was then read :—

ART TRAINING FOR INDUSTRY AND THE SOCIETY'S COMPETITIONS.

By R. A. DAWSON, A.R.C.A., Lond.
(Principal, Municipal School of Art, Manchester).

The present consideration of Art Training for Industry begins and ends with the work of the Royal Sociey of Arts. One of the chief objects of the Society was declared by its founder to be "the training of young people for the pursuit of the Industrial Arts," and its latest work in the organisation of competitions is the most significant effort in that direction that has taken place for a generation.

In 1754 prizes were offered for young people up to the age of 17 for designs for Weaving, Embroidery and Calico Printing, in the hope that their fresh

young minds might produce something less hackneyed than the designs then available. Such offers continued for many years, and in 1778 it was claimed that " the elegance of pattern adopted by weavers and calico printers may, with justice, be attributed in a great degree to the rewards and attention bestowed upon them by the Society."

These awards were discontinued in the early nineteenth century and it is probable that other sides of industrial development claimed the Society's attention.

Since that time we have been " muddling through." We have been told recently that the capacity for doing so, that is " for dealing with emergent circumstance," is possessed by our nation in a far greater degree than by any other people in the world. Civilization has grown from this capacity and scientific principles have been formulated on the results of experience. One result of the muddling has been the growth, during the industrial development, of the idea that science was all sufficient! To show the fallacy of such an idea it is only necessary to ask what influences the purchaser in selecting a fabric or wallpaper? Not the chemical constituent of the fibre or pigment or the speed or method of production, but the appeal of colour, form and texture: the things that move either consciously or unconsciously to himself his inner sensibilities, in fact the artist's expression brought about through underlying and, of course, necessary scientific production.

Historical Notes.

It seems to have been forgotten that art was the first branch of education to receive the serious attention of the Central British Government. As early as 1837, there was established the Central Government School of Design which afterwards merged into the National Art Training School and is now the Royal College of Art. In 1851, the Government established a Department of Practical Art; at a later date a Science Division was added and the combination became the Department of Science and Art.

It is evident, therefore, that in the early years of the Victorian Period, Art was considered of great importance in the development of the intellectual capacity of the people and in bringing about a measure of commercial and industrial prosperity.

During the fifties a comparison of the British industrial products with those of other countries, notably in the Great Exhibition of 1851, brought out very strongly the fact that in artistic perception, in matters of taste, in the application of art principles to industry and handicrafts, we were far behind other nations. It was felt that only by cultivating the arts of design in all important industrial centres could we hope to reach the standard of excellence of other countries and to compete with those countries in the markets of the world.

Hence the Government system of Art Education was developed, having its

root in the central body and its branches reaching to the remotest corners of the land.

Hence came about also the introduction of drawing into the primary and secondary schools and the regular training of teachers to carry on the work.

The excellent work of the Government System of Art Education will, perhaps, never fully be realised, so difficult is it to measure results. Suffice it to say that the results have been prodigious. There is scarcely an artist to-day, be he painter, sculptor, draftsman, architect, designer or craftsman, who has not received some benefit, direct or indirect, from its work. There is scarcely an industry but has been in one way or another aided either through schools and classes or through the provision of the material for study in its museums of applied art.

There has been a fashion in some quarters and even amongst those who have most benefited, to minimise the work of the Government Department in this direction and no doubt there have been, as in every human effort, imperfections too slowly corrected ; methods out of date and too slowly re-organised to keep pace with the rapidly changing modern conditions, these conditions being in part consequent perhaps upon the very success of the movement.

On the other hand, there may have been difficulties which the outsider will never know unless some future historian searching among the official records shall reveal them.

How difficult for instance it must have been at the commencement to organise schools and classes without a proper supply of trained teachers ! How difficult it must have been to devise any system of instruction in art based, as it must be, not upon strictly definite and independent facts, processes and developments, as in some branches of education, but depending for its excellence on the recognition of all the varying subtleties of the individual human mind, the delicate perception of feeling and expression of the " ego " which goes towards the highest accomplishment in art !

In spite of all, however, great progress was made and many of the art centres were flourishing greatly where at the same time some other branches of education were in their infancy. It must be confessed, however, that there was a tendency round about the beginning of the present century to put art education into the background. The aggrandisement of the science and technological branches for a time overshadowed art as a special branch of education and as an important factor in competition.

The reason is to be sought not so much inside the schools of art as outside. The Technical Instruction Act of 1889 empowered local authorities to raise a rate not exceeding one penny in the pound for the purpose of providing " instruction in the principles of Science and Art applicable to industries and in the application of special branches of Science and Art to specific industries or employments."

Previous to this such local bodies were only allowed to aid in the work, but from that time a definite fund was available and in addition to this, in 1890, the Local Taxation Act handed over to the local authorities of County Areas a large sum annually out of the Customs and Excise duties which might be, and generally speaking, has been devoted to the encouragement of Technical Education.

On the whole, the management of the funds entrusted to these local bodies has been satisfactory, but in some cases better expert advice might have been obtained. It is open to question whether the fillip given to Technical Education was beneficial to the art classes and schools already existing in a flourishing condition. The general impression among art educationists is that the change, as in may cases manipulated, was not in the best interests of art. The existing classes were amalgamated in technical instruction schemes and occupied a far less important place than they had hitherto done. Committees of Management too, specially constituted for art classes, were dissolved or merged in some degree in the Technical Instruction Committees. One effect of this was that as the committees became municipalised, the leaders who had voluntarily formed Boards of Governors and Trustees for Art Schools, ceased to interest themselves in the work and various encouragements they had provided in the way of prizes and free studentships were allowed to lapse. Among those who were pressing forward technical education the balance was in favour of a scientific training as more beneficial than an art training and a more potent factor in competition. The idea was prevalent that the funds were better placed on the science and technology side than the art side, and that the science teacher was better worth his salt than the art teacher, however long and arduous the training of the latter might have been.

No doubt the methods of teaching art in its application to industry had not been fully grasped in some schools, nor are they yet fully developed. Also in some schools in the earlier days there was a certain amount of misuse of funds in teaching young ladies to paint pretty pictures from copies. Such cases are merely incidents in the history of the development of the methods of art teaching and it has only required the better training of the responsible teacher to eliminate them. Happily also, the most recent movements of public opinion have been towards the fuller recognition of art as a most important adjunct to all branches of education and of the desirability of the independent and untrammelled control of art education by trained experts in that branch acting with managing committees, and advisory boards, constituted for the purpose.

Most of the Foreign Institutions for the development of Industrial Art have been founded at a later date than their corresponding British ones. This fact has enabled them to model themselves more or less on our lines but also to profit by our experience and to modify the organisation of their work accordingly.

A careful study of some of the Continental Art Schools, their organisation and co-ordination with other branches of education, has revealed the fact that we have much to do still to keep pace and to meet competition in those products to which art principles may be applied.

The Search for Ability.

The primary effort of Schools of Art was to assist industry and although their function has broadened very much during the process of development that effort has never diminished.

The effort is first directed to the search for latent ability to be followed by training to make such ability of the utmost value in the economic and community life. The familiar self-detraction of our nation indicates that the British child is artistically inferior to some other children. This opinion cannot be upheld. Given equal chances our children have as good artistic possibilities as any others. It is only circumstances of unsatisfactory training and cheese-paring methods in a subject where environment and material are of such importance that have kept our young people back. Otherwise they would come forward in greater numbers to take their place alongside the great British artists and craftsmen of the past. Do we not know of English designers, who, to sell their designs, have opened offices in a foreign capital and whose work has been purchased there for execution in their own native district as the latest imported fashion ?

There is abundant latent ability and this under proper management must be sought for mainly in our primary and secondary and public schools. The school course in drawing and art will be naturally directed towards the education of the mass of pupils as future members of the community. But certain individuals will emerge as having ability beyond the rest ; they are not necessarily bad in other branches of education but outstanding in art. The first selection of such pupils will rest with the teacher, so that the first necessity is that teachers of art in general education shall not only have training to enable them to give suitable lessons, but that their horizon shall be extended to take in the possibilities of the utilisation of ability in various branches of work coupled with a knowledge of the right line on which to direct the pupil towards his future fulfilment. An art teacher will be more likely to do this than a general teacher.

From General Education to Art.

The taking off point from general education should receive some consideration. The elementary school pupil is usually tested at about age 12, to determine whether he is capable of going forward to secondary education up to age 16. The examination test is a general one so that a candidate with special ability in drawing may be denied entrance to a secondary education

on general grounds. The nature of the tests is such that he cannot gain full credit for whatever special ability he may have. A remedy for this deficiency in selection would be to give the pupils showing ability in art a special test and if successful such selected pupils might go forward to a secondary school ear-marked for the time being as potential art workers to be transferred to art training or passed into industry at a later date, with the advantage of a secondary education. The pupils remaining in the elementary school from 12 to 14 will consist of two classes :—(1) those who may be fitted for a secondary education and have been kept from it by circumstances of accommodation or by the refusal of the parents' consent to spend up to age 16 in general education, and (2) those declared unfitted for secondary education.

In both classes there may be instances of ability in art. For some of these entrance to industry is necessary at age 14. In the case of others the parents may consent to some *vocational* training up to age 16, especially if coupled with a small allowance for expenses.

Those young people who, of necessity, must enter industry at 14 are dealt with by the Juvenile Employment Bureau. It is a fact, however, that far too many unsuitable boys and girls are accepted by employers without sufficient backing from the schools as to their disclosed abilities. Also employers have not sufficiently grasped the fact that the teacher is the best reference, and again a special art teacher is most likely to supply such a reference.

For the boy or girl of 14 with ability for art work, and willing to follow a semi-vocational training to age 16, provision has been made in most of the larger centres. Such pupils may be selected to attend a junior pre-apprentice school within the School of Art where their general education is continued to a secondary school standard and where they have special training in drawing, design, colour, craft, adapted to their future selected work.

In the larger centres, some of the selected elementary school pupils who cannot be placed in a secondary school or who do not wish for that type of education are now placed in Central Schools where their general education is continued with a slight vocational bias. In these schools there are usually specialist teachers of drawing and art and the selection of art ability becomes more confident. There are possibilities of scholarships and transfer of attendance at about age 15 to 17 to the School of Art for vocational training. It is quite the regular thing now for Secondary Schools to have well qualified art teachers so that the possibility of good selection for specialised art education by means of scholarships at a School of Art or for entry to art industry on leaving the Secondary School is better assured than formerly. In fact there are many cases where the art instruction of the Secondary School is under the guidance of the School of Art and proper co-ordination is possible.

Speaking of Secondary School pupils, it must be remembered that only a limited number are eligible for scholarships. Hence Schools of Art receive

as fee-paying students secondary school pupils whose parents can allow them a further period of study and who have found their special ability and attraction to be towards art work of some kind.

The mass of students in the lower divisions of a School of Art from which the upper division draws its supplies, therefore, consists of:—

(1) Pupils from Elementary Schools commencing work at 14 and attending in the evenings only.

(2) Selected pupils from Elementary Schools taking a combined full time pre-apprentice day course in general education and art, age 14 to 16. (In some centres 13 to 16).

The specific industry may be afterwards decided or the pupil may be booked for entry to a particular industry and even promised an opening.

(3) Apprentices attending part-time in the day school as well as evening classes under continuative education schemes.

(4) Pupils from Secondary and Central Schools entering at age 15 to 16 for Full-Time or Part-Time Training.

(5) Pupils from Secondary Schools entering at 18 or over for Full-Time or Part-Time Training.

(6) Workers in various branches of activity who, having ability, or who, having discovered such ability at a later age, find themselves in a non-artistic business, and who are attempting in Day or Evening classes to qualify in art in preparation for a change of work, or, failing that, to satisfy a desire in life that their work has failed to fulfil.

As regards the last named, it is to be understood that there are many engaged in business of a non-artistic kind who would have been better fitted for art work, just as there are those who are filling a place in art industry with a minimum of suitable ability. This in itself shows the importance of proper selection in the early stages, of the recognition of the possibility of late development and of the arrangement of facilities for transfer from one class of employment to another.

It will also be noted that Schools of Art, to meet the requirements of various types of students, run two schools, day and evening, the whole of the day programme being followed in the evenings together with additions. Being a specialist school, every student should be required to train thoroughly for some specific branch of work. It is not possible to any extent to differentiate the curriculum as between the person who *must* earn a living and the one who *need not*. The latter may eventually become a professional. Further, the education of the general public in art appreciation can better be followed up as a separate division of the school's activities through extra-mural lectures and exhibitions or through special adult classes. The training of the art worker might be endangered by modifying procedure in the direction of any limited or unsatisfactory requirements of the amateur. Under a proper system periodical tests will act as a means of sifting and will ensure that only those who show possibility of further training are passed forward to the upper division.

It is significant of the time that extremely few students now attend a school of art as a pastime. Practically all wish to train definitely for some branch of art and to reach a professional status.

ENTRY INTO INDUSTRY.

Out of the conditions outlined important matters arise for consideration. It is clear that only a limited number of the students selected for art can pursue their studies to the highest point of training, and they must enter industry on various planes low or high, according to economic circumstances in the home, or according to limitations of ability. Even those who enter industry without a school of art training vary in age, those from an elementary school being 14, from a central school 15 or 16, from a secondary school 16 to 18.

The extension of school age has had an effect on the possible training for industry. Previously the elementary school leaving age was 12, and the apprentice took up indentures at from 12 to 13, attending the art school in the evening. He is now apprenticed at 14 to 15 and schools of art do not, as a rule, accept pupils under that age. The secondary school pupil who previously went to business at 16 and attended the school of art in the evening from 16 is being pressed to remain at school up to 18. In the art school the selected pre-apprentice pupil is kept at school till the age of 16 and the art scholarship holder may remain in training till 18 or for the higher positions later. The effect on the school of art is that the students both in evening classes and in day classes start at a later age than formerly. They start with a more extended education and those entering day art classes at 14 have the advantage of continued education up to age 16. It follows that some of the work done by schools of art in the past may now be done during extended education at school and whether this is any advantage depends on how this work is done at the schools in the case of selected art students during the period immediately prior to entering the School of Art. This work which should become of a vocational type may be and in some cases *is* assisted by the staff and equipment of the School of Art. If this extended period of general education can be properly arranged in the case of selected pupils then schools of art can by degrees eliminate their preliminary courses and can, after an art entrance or matriculation examination, accept students in day classes for intermediate courses leading to a professional qualification much as the Universities do.

There is another aspect of the extension of the School leaving age that seriously affects industry. A pupil cannot now become apprenticed before age 14 and firms have had to recognise this. Under present conditions, however, young people, the selected ones, wish to continue their education and training so as to take the fullest possible advantage of modern facilities and to enter industry at a later age according to circumstances. It should be noted that an entrant at 16 is better equipped than one at 14 and one at 18 has carried

his artistic development further still. There is a tendency in the Trade Unions and among some employers to ignore this and to demand that the apprentice shall begin as in the past at the earliest legal age, namely 14. Further, it has become customary for the Unions to settle the wages of apprentices from 14 to 21 as a definite percentage of men's wages. This is quite a proper thing to do as a deterrent to exploitation and given proper school training to the age of entry should work equitably. Actually there is at the present time difficulty because on the one hand the boy with school training does not expect to start in the old way by sweeping floors and running errands, and on the other some employers declare this is how he *must* begin, and hence they are unwilling to pay the appropriate wages of his age and the applicant is turned away. In some cases the employer disparages the training received in school and this usually leads up to an offer of lower wages or no wages at all.

Industry, it is clear, through ignoring modern movements in education is not yet reaping the full benefit of the extended facilities now provided for training and a remedy should be sought. At least one industry has provided the remedy and that is to recognise school training under proper conditions as in lieu of apprenticeship. The worker thus can enter at any age with a proper wage and it is open to the fully trained artist to enter at 21 or over without shop apprenticeship, thus bringing to industry the possibility of advantage on the highest artistic plane. It is recognised on all hands that under modern conditions shop training is not enough but should be supplemented by school training. To this end masters and men, putting aside their differences in other respects, should broad-mindedly combine for the proper training of their apprentices and should co-operate with the schools so that their advice may be of value in developing suitable curricula. Advisory Committees have been and are being formed as part of school organisation and as a means of co-operation.

As regards the higher branches of art work it should be remembered that other professions look for entrants at ages from 21 to 25, school training being regarded as absolutely essential. The best organised of the artistic professions, that of architect, has definitely decided that school training is to be required as a professional qualification, and that the old method of articled pupil shall be discontinued as soon as circumstances will permit. Under a system of school training there would be possible control and selection of entrants, co-operation in training, definite filling of openings, equitable scales of salary, trial periods in industry before completion of training, transfers between districts, recognised standards of attainment.

For the higher professional positions the standing of the artist in industry must be assured. An educated artist with a graduate training must be treated as a professional man as in other branches of work. His advice on artistic matters must be thoroughly considered and he must be honestly given the remuneration that is his due as one of the principal selling factors of the firm.

SCHOOL TRAINING.

Let us examine now the internal organisation and method for present-day training in schools of art. Like all other institutions these have had their share of criticism, but seldom of a constructive kind. The protagonist of the fine arts declaims against the wickedness of training young people with ability in art to earn a living by its means. The keen industrialist cries out for more accurately formed cogs to fit into his own particular machine The workman says he learnt all he knows in the shop and why send a boy to a school ? The very materialistic man says " Why cannot the schools be more practical ? " The industrial leader, with trained artistic perception, says " Give us artistic creative ideas." The taxpayer says " Why should we provide public instruction to help industry ? " The private artist says " Why not leave the amateur to pay for his training in a private studio ? " The Trade Union acknowledges it has not yet decided to require standards of efficiency. The young person says " If standards are not required why trouble ? " Some employers say "Why should an apprentice who is content with his job be developed for a higher one ? " The critic who has never been in a school of art since he was a student 30 years ago says the school is entirely behind the times. The traditionalist shudders at the idea of machinery, appliances, and trade work in a school of art. These are a few of the criticisms, if they can be called so.

It is the business of those responsible for the schools to keep a very clear head among such confusion and that being the case schools go on quietly doing their work, watching that it is done as well as possible, examining all new suggestions, modifying schemes if there is any chance of improvement and withal being acknowledged as doing a great work for the community.

There has been constant development. In spite of difficulties the schools stand to-day at a higher point than they have ever done before and their possibilities of training are as good as, or better than those of other countries. They have had increasing influence upon industry. They have influenced the community. Most of the modern associations, cliques and coteries having ideals more or less towards the advancement of art have grown out of the extended range of art education having its primary root in the schools of art and developed under the Board of Education since 1851.

THE QUESTION OF TEACHERS.

The earliest teachers under the scheme had to be found ready-made—they were amateur or professional painters or workmen who had interested themselves in art without knowledge of teaching methods. The aim could not extend much beyond the provision of training in drawing and painting to be applied in whatever direction the student could find. Later, certain minimum qualifications were required and the necessity of some training in teaching was recognised. Hence the National Art Training School was utilised, now the Royal College of Art.

We hear a good deal nowadays about the necessity for the teacher to be a worker in some branch of art. He always was from the very start but that is not enough. Teaching is an art in itself and a worker in art cannot expect to do it well without some study of the subject and without some special ability and liking for it. One of the greatest developments of recent years is that teachers of art with the necessary education who are to be recognised for responsible work must, in addition to the study of a branch of art up to a high professional standard, devote themselves for one year at least to the study of the teaching of art in its various phases. In this respect art teaching has advanced to the position and beyond of teachers in the higher educational institutions. The art teacher's qualifications take at least two years longer to obtain than those of an ordinary graduate.

Again it has been stated that an art teacher must continue the practice of his art. That again is true and has always held. In the early beginnings it was more possible than now. The very success of the work has gradually curtailed the teacher's free time and surplus energy so that the success has, in many cases, entailed grievous sacrifices to the loss of creative art. This is more keenly felt during a period of supposed economy affecting staffs and sizes of classes. There will be necessary always a number of teachers whose first business is their teaching work and from whom the sacrifice of an artistic career may be necessary for the continuity and stability of the work, but it should be possible also to have specialist teachers who, whilst having freedom from economic anxiety, have sufficient time and energy reserved to carry on experimental artistic work. At the same time there is room for specialists who, whilst depending primarily upon their professional work, teach for limited periods in specialised classes.

A criticism has often been advanced that schools of art were too ready to turn prospective art workers into teachers. This criticism has held since the early days when National Scholars, selected from Industry, were taken to the Royal College of Art for further training. It is true that these, as well as Royal Exhibitioners frequently turned to teaching as a means of earning a salary they thought they were entitled to. According to the critics these would make the best teachers. But it is agreed there was a consequent loss to industry for a time. The remedy would have been the recognition by industry of the extended experience and the offer of appropriate salaries at the conclusion of training. At the present day I would urge the value of such training and of keeping in touch with a worker undergoing it with a view to his return, by previous promise or otherwise, into industry with the added experience. But the turning of a scholarship holder into a channel other than the narrow one originally intended is always a human possibility.

It is important that the School should be ready to recognise the qualities of a good teacher coupled with ability as an artist and it is, in fact, just as ready to

advise an intended but impossible teacher to give up the idea as to advise possible teacher to develop that side of his ability.

Before proceeding, a few more remarks on the criticisms may be useful: First, the school does not and never can supply a complete shop or atelier training; that is impossible, but it can largely supplement industrial training in a way not possible in the workroom. Neither can it undertake to train solely for the special methods of a particular firm. It can provide opportunities for stepping forward to higher art training and can show the employer the special abilities he can use. The selfish and uninformed criticisms need no answer; and matters belonging to future development will right themselves under proper support and friendly co-operation.

Compulsory training of the apprentice should be carefully considered by all concerned, because the young person has rarely the knowledge and experience, nor the disciplined self-control to know and to follow what is best during the adolescent years. Guidance often fails. To improve the apprentice and to raise the standing of industry we may make extensive provision; there may be no effective result and funds wasted if we do not see to it that young persons take advantage of the training offered. It would be a reasonable thing to extend what is at present done in some quarters, namely, the granting of time for the apprentice to attend at the school of art during the day, this being conditional upon attendance in his own time during the evening. It is only by some such method that industry will reap the full benefit of the funds expended on its behalf.

Graduated Courses.

Throughout the development of art education and training it has been recognised to an increasing degree that man does not live to work but works to live. And as in general education, so in art, it has been the aim to bring out all the latent artistic possibilities. Consequently, even after a young person has been selected for an art career it is felt that his early development should be broad, that several doors should remain open and that even when one definite opening has been entered the full possibilities should not be neglected. That is, where the vocation takes up a limited portion of the abilities, the remainder should have opportunity of developing so that if the vocation cannot utilise these they shall be cultivated to the benefit of the non-vocational intervals and towards the fulfilment of individual and community life. Courses of instruction are therefore provided in which, whilst the vocational side is kept in view, the subjects of a broader type ancillary to the vocation are not neglected.

The internal arrangements of a school will naturally vary with its size and circumstances. It is known that some critics, generally with no knowledge of art education advance the view that definite arrangements cannot be made for art development but that it should be allowed to flounder as it will.

If we recognise the various degrees of experience and development of students, we shall wisely adopt a scheme of graduated progression basing the later stages on success in the earlier ones. If we recognise that study may be for different ends, we shall accept the principle of differentiation for specialisation. If we recognise that various mental faculties and various physical possibilities are necessary in human work, we shall accept the principle of development through varied subjects concurrently followed up as a course. If we recognise that latent human possibilities do not necessarily reveal themselves at any specific age we shall agree first to a broad fundamental training with possibilities of experiment followed by specialisation later. Further, if we realise that a student may have to enter industry at an early state and engage in very definite and perhaps somewhat mechanical operations we shall desire the early training to provide such discipline of hand and eye as may be required.

We shall follow the line of thought better perhaps if for the present we regard art as a human sensation or re-action of the senses deliberately arranged and imparted through the medium of material: the spiritual and mental through the physical and material—art through craft. Both the spiritual and the material side can be cultivated, stimulated and developed. Then if we could use the word craft as meaning the cunning use of the material rather than as meaning the whole of the artistic effort, we shall keep our ideas clear.

An *artist craftsman* is one who, eager to impart the reactions of a delicate sensibility, has learnt to control his material to that end. A craftsman purely is one who, whilst having keen interest and delight in the control of material is limited as to the mental and spiritual reactions he would impart. We might call him a *trade-craftsman*. There is naturally an infinite gradation between the two.

So far as present experience goes, modern requirements, whether we like it or not, are bringing about two broad aims in our schools of art. One is to provide training for the trade-craftsman and the other to provide for the artist-craftsman with full possibilities of the creative artist to become efficient in the use of his material and for the trade craftsman to develop his artistic possibilities.

The method at present suggested is to provide graduated courses of study for normal artistic development on the one hand with workshop or craft training on the other. At the bottom of the school would be a preliminary or general fundamental course involving study and practice in certain subjects essential to every branch of art, and providing the discipline of hand and eye required in the earlier grades of industrial work. This preliminary course might be in part covered in the final period of general education and in fact is covered more or less in some Central and Secondary Schools. Along with this preliminary course opportunities would be provided for experimental work in branches of creative design and craft with a view to coming nearer a decision as to future specialisation. In the case of evening students already engaged

in some specific industry or craft, school study of the special branch would be provided for, together with such portions of the preliminary art course as may be deemed necessary.

Following on this there would be intermediate courses of normal art study forming the Lower School open to suitably prepared pupils of secondary schools, to those who have satisfied in the preliminary course, and in part accessible to trade craftsmen alongside their special trade class. These intermediate courses would provide for partial specialisation under the headings :—(A) Industrial Design, (B) Modelling and Sculpture, (C) Drawing, Painting and Pictorial Design, (D) Architecture.

An intermediate course involving one main branch would include portions of other branches as found desirable. Crafts and Trades would form distinct sections and the courses for trade workers would include appropriate subjects from the normal art course. In certain classes of the normal courses, therefore, the student with artistic ability searching for an outlet would meet the student who is already settled in some branch of industry. The same would occur in the craft and trade classes where the former is experimenting in the control of material to express himself whilst the latter, experimenting in work supplementary to his trade, is widening his artistic possibilities. Each course would include the study of form and its expression, the direct study of nature and the storing of the imagination, the technicalities of the industry or craft and continuous experiments in creative work.

In the Advanced or Final Courses of the Upper School complete specialisation in one of the four branches named would be provided for and at this stage the exceptional trade craftsman working through his trade to the highest artistic possibilities would be ranged alongside the professional artist. Such an arrangement, with recognised standards of attainment at each stage, with essential subjects combined with optional ones to suit individual idiosyncracies, would provide all that has been suggested as necessary. Further, it would provide for possible transfer of a student from one branch to another in the search for the most suitable line.

Beyond the Upper School there would be provision for post graduate work, refresher courses for workers in industry and opportunities for special experimental and creative work.

Referring for a moment to recent developments in France, we find again that some of the ideas developed from our muddling along have been clarified and are being put definitely into practice in the City of Paris, in accordance with the peculiar circumstances. The method differs somewhat from what is suggested as possible here. There the Primary, Pre-apprentice and Part-time Complementary Courses appear to be thoroughly co-ordinated. An effort is made to have the primary drawing well done by qualified teachers who, particularly in the higher classes from age 11 to 13, have followed for

one or two years the lessons in art pedagogy of the Normal Drawing Course established by the Municipality.

From about 13, the pupils are taught by specialist professors diplomatized by the Municipal Authorities. This period would correspond with our Secondary and Central School Courses, in which there is a growing tendency with us to utilise highly qualified teachers.

In addition the municipality of Paris has provided a series of separate trade schools, five for boys and seven for girls, which are superseding the schools previously carried on independently by the trades. These Municipal Trade Schools provide pre-apprentrice and complementary day courses, including general education, drawing and design, together with practical work in a definite art trade or industry.

Having secured good training in the day classes, the evening classes provide opportunities for complementary, continuative and refresher study.

Further, art education can be followed up at the two State Schools, that of Decorative Art and that of Fine Art.

Such an arrangement it is understood is being followed among other things in London, but the method of grouping the various branches of trade in one institution in co-ordination with a course of training in drawing and design, etc., would appear to be more economical and more suited to the majority of provincial towns. In such a grouping certain local trades might be specially provided for, with more general provision for those in which there were smaller numbers in training. The suggested upper division in fine and applied art would make the scheme complete.

Co-Operation Between Schools and Colleges.

Such a school or college as that outlined would undoubtedly be of University rank and would grant its own diplomas. It is suggested that the standard diplomas and certificates should be looked for by employers as indicating a satisfactory completion of a school course; such recognition would do much to lessen the present uncertainty of the artists' standing and would help employers in selecting the right type of man.

Such a school would naturally have an efficient staff of teachers of all types, suitable equipment, examples and library and with its complete course would form a centre for a wide area. Its aim, however, would not be to draw together all students from that area but to affiliate the smaller schools providing satisfactory parallel courses and to co-operate with them in the bringing out of the special student for entry to the final diploma course and for post-graduate training. Further, such a school would co-operate with other schools of similar rank in matters of standardisation of diplomas, so that these could be confidently recognised as of proper standing.

Such a scheme of co-operation among the large schools or provincial colleges

of art cannot leave out of account the Royal College of Art. This institution, at one time the only school where a higher training in art could be obtained, no longer holds that isolated position, neither do all the best students go there. Two ways are open to its development, either to form for the London district a college similar to the provincial colleges in their districts, or to provide post graduate study with the advantage of the London Museums and Galleries for diploma students from the provinces; or both aims might be combined. In any case the time has come when there should be more co-operation between the district colleges and between them and the Royal College and a distinct recognition of the satisfactory completion of a course in the provinces as covering certain courses at the Royal College, to insure that provincial students shall have full advantage of a higher training in London, continuing without set-back their previous work. Such co-operation would work in the interests of industry and meet various desirable co-ordinated arrangements such as the transfer of a student by Scholarship or otherwise to the district adapted to and providing the required training in the highest degree. If the co-operation could extend downwards through the schools of art to the secondary and elementary schools and could include more thoroughly organised co-operation with industry, then the ladder of art training for industry would be completely constructed.

Launching the Trained Student.

Equal in importance to the selection of the young entrant to industry and his training is the question of the launching of the student who has remained in training and reached some standard of efficiency as a creative artist and as part of this question we may come now to consider the Society's Competitions. It must be remembered that up to the year 1915 there was held annually by the Board of Education what was called the National Competition and Exhibition of Work from Schools of Art. The avowed reason for its cessation was economy. It had somewhat outworn its usefulness however. Its advantage was that it gave a yearly opportunity for a selection of the best work of the schools to be placed before the public generally and before industrial leaders in particular, and it was possible by its means to bring out some of the best ability. It had, however, wrongly come to be a means of assessing the work of schools and some were compelled to use its results in medals for that purpose solely. Thus it produced a keen rivalry and lack of co-operation among the schools, gave a wrong trend to the school curriculum, and led to various evils and unsatisfactory assessment that need not be detailed here. Hence many teachers did not mourn its loss and the majority do not wish for its revival.

The cessation of the National Competition in date coincided almost with the change of policy of the Board of Education as to its examinations involving the holding of higher examinations only. The onus of the lower examinations and the arrangement of courses was suddenly thrown upon the schools themselves.

It would appear that some were possibly not prepared for this and having depended upon the Board's syllabuses and worked to them without study of the problems of art education suffered a set-back in consequence.

To some the change of system presented opportunities for consideration of the whole problem of art instruction untrammelled by the National Competition and as a result courses of study have been developing far in advance of previous schemes and supplying real training for the various needs and occupations. These will assist industry in the direction of creative art to a greater extent when the Board's higher examinations to which they lead may be modified so that training for a definite branch of art work can continue uninterruptedly. At present in some branches it is necessary to turn aside and to follow an academic course in drawing of a very advanced character.

THE COMPETITIONS OF INDUSTRIAL ART.

Those who had been compelled to depend for status upon the National Competition felt its loss and when the Society's Competitions were established they appear to have been welcomed as a possible substitute for the National Competition. Although to an extent these competitions in their methods are superior, they bid fair to revive all the evils of the National Competition and to introduce other dangers if not evils arising from the fact of their separation from the educational anchorage.

One encouraging thought to-day is that so many influential bodies desire to help in the mutual interests of art and industry. An instance of this is to be found in the Federation of British Industries with Mr. Charles Tennyson as leader in this matter. The great fact that cannot be passed over is that the Royal Society of Arts has brought together in its competition committees a body of men prominent in the industrial world and vitally interested in the production of industrial artists and workers. By the co-option of a representative of the Board of Education this body has been extended.

This Committee of eminent leaders has a very able Chairman in Sir Frank Warner, K.B.E., who has shown such a keen interest in art and industry in the past.

So far as educational institutions go, the Royal Society of Arts is an outside examining body but with the weight of its Royal Charter and by holding its exhibition in the Victoria and Albert Museum, it appears to carry educational authority. Its competitions are arranged and, it is feared, adjudicated purely from the commercial point of view. Consequently, the encouragement is given solely to students along those lines and work is intentionally premiated or purchased, which suits individual firms and their immediate requirements for trade. We can put aside as unworthy the suggestion that is usually made of any art competition, that the donors get a cheap selection of designs. There is every reason for saying that commercial and industrial work *should* be

encouraged an usable talent brought out, but the work contributed does not satisfactorily indicate the efficiency of the work of schools of art, which includes the encouragement of artistic production of the highest description, making the standards of trade possible of advancement and training artists to lead rather than to follow.

It is not competent for an outside body to judge and report on the work of educational institutions whilst having no official connection with them and whilst the conduct of those institutions is in the hands of other bodies. The fear is, and it is supported by remarks in a well-known magazine, that the schools are being judged as a whole by the competition work exhibited.

It is agreed among art teachers that periodical exhibitions are desirable, but if these are to be taken as school work they should show the best the schools can produce.

It is now believed that in education the *course* is the thing, and isolated successes in single subjects do not necessarily indicate really good ability. Any competition, therefore, that tends to draw students from their course is not to be desired and would check the recent beneficial work of orderly art training. Any award that would encourage a student to keep to his course regularly and earnestly would be welcome, as would also any competition among senior students who, having completed a course, are ready to cope with industrial problems with a view to launching upon a career.

The exhibitions should show the accomplishment of a trained student ready for the highest employment rather than the spasmodic effort of the immature. The experiments of the latter would be best shown, if at all, in a special educational exhibition.

The difficulty at present in some schools is to differentiate between those students who are prepared and those who are not prepared to enter competitions. If a condition could be laid down indicating the required standing of a competitor or if the competitions could be modified so as to provide for lower and higher courses, that again would be more satisfactory, but difficult under present conditions. Perhaps the only thing possible is to impress strongly upon all concerned that the competition is for those who have completed a satisfactory course of study. The schools are suffering in the eyes of industry because students are accepted as trained creative artists when they are still immature, not having completed their training. Then every opportunity should be taken to inform the public and the press that the work does not represent the complete work of the schools of art.

A visit to the exhibition of 1925 showed that when the works have been selected for hanging, it is in some cases practically impossible between a certain limited number to indicate which is deserving of the prize, and that a lottery might settle it.

The suggestion now made is that the work should be selected for hanging

from the highest standpoint with due appreciation of the industrial side and the possibilities of the schools. Donors should then have the first opportunity to purchase designs from the selected ones or to select possible designers or to offer help in other ways. For any important award, however, the selected exhibitors should be required first to submit full particulars of their training and professional aims with further examples of their work and these being satisfactory should be invited to a final personal test, under conditions to assure unaided individual work. The awarding of a single prize or the purchase of a work does not aid much in launching a student who is looking for a living, and other options might be suggested to help him forward, such as—the offer of a post as designer, the offer of continued support as a free lance, the payment of a premium to go into a firm or atelier as improver, the provision of funds for setting up an atelier, the provision of travelling to study the subject concerned, the payment of fees and maintenance at a higher institution.

Non-Industrial Art.

Having said that Schools of Art wish as one side of their business to encourage work of the highest artistic order without reference to selling qualities, I would like to urge the encouragement by industry of this individual and experimental art of an independent kind. After all, commercial work implies some intention to commercialise, that is, to produce with a special intention, and to produce by such economic means that the intention can be realised with the greatest advantage to the producer. Mass production suggests modification of something that has been already conceived—rather a reproduction in quantity of what has had a unique character and individuality. The greater and broader the original conception is, the better the commercial product is likely to be. Again commercial production is necessary to provide quantity to meet a demand. Should that demand shift to a higher level the supply must follow and should the quantity of the demand be reduced the tendency will be towards the production of fewer and better. If the original conception on which commerce is based sinks to a low level, the commercial product goes correspondingly lower. If there is any desire to raise the level of commercial products then the individual creative artist must continue to be brought out and trained to produce on the highest possible level; he must continue to lead and to lead constantly higher.

The cry " We must educate the public " is becoming less justified. The public in this country and abroad is being educated by varied means—newspapers, magazines, books, pictures—and it is known that firms that are alive and advancing in artistic production and in the raising of standards of taste in their goods are always busy.

Hence in an exhibition representing schools of art, this type of work should be stimulated, not only in the interests of the advancement of life, but in the

interests of advancing standards of industrial production, of trade, and commerce. Might it not be possible to hold such an exhibition under joint organisation ?

There is not time to discuss the place of the machine and handwork in industry and education. Neither is there time to touch on the important work being undertaken in the schools for the training of the middleman, the salesman and its effect on industrial art—the part to be played by museums and libraries and pattern rooms—the question of research work in industrial art in relation to senior student and staff—the work of the Employment Register in schools of art for local employment and its greater use by industry—the work of the Employment Bureau of the Federation of British Industries for non-local employment—the question of costing in schools—the co-operation between art and technical schools—the obtaining of lecturers from industry and how industry can further help the schools.

In conclusion the suggestion is made that—after all—the *basic industry* of the British Nation is the development to the full of the abilities of its people.

DISCUSSION.

THE CHAIRMAN (Sir Frank Warner) said that everyone would agree that the paper had been very interesting, well thought out, and lucidly expressed. Mr. Dawson had made some useful suggestions which the Council of the Society, he was sure, would consider in due course. He would not say much from the chair, because he desired that others should express their views, but he did wish to say something about the Society's competition. The most valuable feature in connection with industrial art was the growing interest taken in it by public bodies, industrial firms, and the public generally. The efforts that were being made by the British Institute of Industrial Art, the Design and Industries Association, the Textile Institute, and the City Companies, particularly the Goldsmiths' Company, were of great assistance in helping forward the movement for the improvement of designing. All these efforts were welcomed by the Royal Society of Arts, and they did not compete with what the Society itself was doing. The aim of the Society's competition was to bring the work of the designers into direct contact with those able to use it. Through this competition two scholarships of £150 each had already been awarded, one to a textile student of the Regent Street Polytechnic, who was now travelling in France and would later on go on to Italy. The other scholarship was awarded in the architectural section to a student from Melbourne, who was now spending three months in Italy, and would afterwards go on to Spain. He was told that both these students were tremendously enthusiastic about their experiences abroad. Two other similar scholarships had also been awarded.

Since the scheme was published, it had been compared by some people to the National Competition, but the Society's scheme was on a much wider basis and on more practical lines. The Society's competition was open to all British subjects, the other was confined to those in schools of art. In 1924, the first year of the competition, there were 553 competitors and 1,408 designs were sent in ; last year there were 813 competitors and 2,033 designs. The scheme had been a great success, and had received widespread support from trade and industry, and it was evident from the number of competitors that it had been popular with the designers. He

did not wish to lay any particular stress on numbers, however, but he did wish to say that the quality of the designs in the second year was infinitely superior to that in the first. Those responsible for the competition wanted to see an improvement in quality rather than in numbers. There was a certain school of thought the motto of which appeared to be, "Do nothing practical for fear something useful may result!" The success of the Society's scheme was because it was pre-eminently practical. The author did not need to fear that any budding art genius would have his future ruined or even retarded by the competition. Good design was done before the State-aided schools of art were ever thought of. What was needed for industry was schools of arts and crafts, or art schools working in close co-operation with technical schools, so that the student could divide his time between the study of art and the study of the materials on which he would work and of the machinery which dealt with them. There was a fear, he thought, that some of the schools thought more of the school than of the student. It was very much like being more concerned about the cradle than about the child. For his own part he was out all the time for the "child," and he did not mind what sort of "cradle" he had. He would be sorry if the academic side turned the cold shoulder to the practical side. Hearty, sympathetic co-operation between the two was what was wanted. In any case, the Society would carry on, because it was confident that it was doing a good work and was helping forward the industries of the country which required designs, and at the same time giving a helping hand to the designers themselves.

There was one sentence in the paper on which he would like to make a word of comment: "They (the Society's Competitions) bid fair to revive all the evils of the National Competition and to introduce other dangers if not evils arising from the fact of their separation from the educational anchorage." Well, "anchorage" meant a place of safety, and he was not quite sure that an anchorage was quite the right place for industrial students. For those who were studying for the fine arts, or were studying art for art's sake, an anchorage might be very desirable, but he rather felt inclined to say that for industrial designers a little navigation of the ship might be useful. It would introduce them to the kind of experience they would meet with when they had to enter upon the stress of life. The world was not "anchored," and industrial students, like others, had to be prepared for that. Another quotation was: "Any competition, therefore, that tends to draw students from their course is not to be desired and would check the recent beneficial work of orderly art training." When he (the speaker) looked at the work shown in the Society's Competitions, he could not imagine that these poor nervous students of seventeen and eighteen years of age need be upset, because once a year they drew a design and sent it up for competition. He had finished his own studies in Lyons and was engaged in active business long before he was that age, and he was none the worse for that. A large number of industrial students were working already in the mills or elsewhere in the employment of industrial firms. He took it for granted that those students who were being taught in the schools had shown an aptitude for drawing and designing. Therefore, it could not be any great strain upon them to draw one design for competition. He rather feared, from the large number of young people going about the country with bundles of "designs" under their arms, that there was a good deal of teaching in art schools to people who could not design and never would. Then there was still another quotation he would like to make from the paper: "A visit to the exhibition of 1925 showed that when the works have been selected for hanging, it is in some cases practically impossible between a certain limited number to indicate which is deserving of the

prize, and that a lottery might settle it." That showed how thoroughly the author appreciated the difficulties with which the judges had to contend, and it qualified him to act as one such himself! When he (the speaker) had been put in front of a row of designs, perhaps eighteen in number, all of them looking very much of an equality, he had often wished that in some way Providence might remove seventeen of them, and so leave him with only one to judge!

Mr. G. P. Baker said that he would not venture to deal with the paper itself, but he would like to ask the writer one or two questions. He wanted to know whether in Manchester, at the art school over which he presided, there was any advisory committee of manufacturers and merchants to co-operate with him. The writer worked in quite an ideal city for this purpose, the centre of a very large industry, that of calico printing. He wondered whether there were many people in that room who knew that in Paris there were no fewer than 16,000 professional designers—men and women engaged in all branches of industrial art in which design was needed, from ladies' coiffures and chocolate boxes and perfumery right up to furniture. They were all getting a living, and the sad thing was that there was nothing analogous to it in this country as so large a number represented a great industrial activity. There were even Manchester designers—at least he had read of one such in the newspaper—who had established themselves in Paris. It actually paid British people to go out and settle themselves as designers in a foreign capital. What could be done? There must be co-operation with industry. How far was that co-operation going on in the writer's own city? The committee directing the affairs of the art school should include men engaged in, say, textile printing or metal work or the industrial applications of whatever was taught in the school. They had all been told that industry was not co-operating. That, in his experience, was not the case. In his own works several students had been received from the art schools, and he would like to say that they had learned a great deal since they came into the workshop. All he asked of the art school so far as his own industry was concerned, was that it should teach the student to draw, then it should teach him to draw from memory, and finally it should teach him to introduce colour schemes into a design. A good design might be ruined by being badly coloured, and a bad design might be made marketable if properly coloured. Colour played a far more important part in the selling of an article than was commonly believed. He should also saturate himself with form and colour at its best. The suggestion which he threw out might not be of any use to the Principal of the Manchester School, but it came from a manufacturer who had had some experience of designs and designers during the last forty years.

Mr. W. Turnbull said the trouble was that men like Mr. Baker and himself—men in industry—could afford to ignore the art school, and it was a pity Anybody who was looking for textile designs regularly as he was—he supposed he saw some thousands in the course of the year—was driven to the conclusion that the art work which was generally material to the industrialist was that which was produced either in his own studio or, alternately, was produced in an outside studio and more or less under his supervision. In other words, it had to be realised that there was such a person in industry as the "producer." The producer very often was a man who was entirely opposed to art education as understood in a school of art. The author might be interested to know that within twelve miles of his school in Manchester the speaker's firm had a studio which

had in it half-a-dozen people, not one of whom had come from any school of art. He would like to explain how these designers came to occupy their position. One went round one's works and saw a bright girl, and the question arose, "Could she draw?" She was given some paper and allowed to make the attempt. Or one came upon a boy as to whom the same idea suggested itself, and he was given a piece of wood and a penknife and told to cut his initials. It was discovered by that means—often it entailed careful elimination afterwards—what persons in the works had ideas in their heads and talent in their fingers, and this having been discovered, the firm developed it, and it was necessary, unfortunately, to see that art-school training did not interfere with their aptitude and its development. Whether the result was satisfactory artistically or not, might be a moot point, but he would like the author to pay him a visit and see the type of work which these people were doing. With regard to long courses of art school study, he wondered whether these had not the effect of crowding out imagination. He would very much like to see some system whereby the school of art youngsters could have workshop training, be taught to use their eyes, and also be taught the proper use of museums. They also might be given some idea as to the responsibility which attached to artists with regard to the public, and some notion of general art ethics. He hoped that the author would take his criticism in the spirit in which it was offered.

MR. HENRY G. DOWLING said that it was interesting to hear the author say that "the present consideration of art training for industry begins and ends with the work of the Royal Society of Arts." He thought that principals of schools of art in general ought to welcome the scheme that had been founded by the Society in order to encourage art in industry. What training in art the speaker himself possessed he owed principally to the school of art. In his position he had to see many hundreds of designs, and he made it his business to spend as much time as possible helping the students on the lines which he thought industry called for, believing as he did that the average school of art student did not get a sympathetic treatment from the manufacturer. If he saw a designer coming in with a group of designs which showed no ability whatever, he told him, diplomatically and kindly, that there was no hope for that work in industry; but where he found evidence of ability he encouraged the designer, perhaps letting him go through his firm's shops with the idea that he might bring back a design adapted to the requirements which he found there. If the schools concentrated upon training the students to draw, the industries afterwards would turn their trained ability in the right direction. He went on to refer to the way in which the salesmanship side of business could influence public taste. The retail salesman probably influenced public taste more than any other individual. There was here a field for those who had artistic ability short of ability to design. He also said that he had known instances where youths and girls had gone into the employment of large stores and sooner or later an ability to express themselves on paper had come to the notice of someone who mattered. Only recently he heard of a young woman who went into a famous West End establishment as a saleswoman, and to-day she was doing about two days a week wholly in design work. It was to this field, he thought, that schools of art might very well turn their attention. He did not think that as manufacturers they wanted to counteract school of art tendencies, they were only too keen to harness the school of art into their business. But schools of art should be aware of certain industrial requirements. For instance, there was not the scope to-day for wall-paper designers, and to train designers in the school for wall-paper designing was a fatal mistake. It would be well to train

the designers to adapt themselves to cretonnes or something similar. He believed also, that the schools of art had neglected entirely the needs of the large stores for artistic window display. In all this matter there must be practical ability. There were some students who shone as artists and had no practical ability whatever. Perseverance was necessary also, as well as artistic talent. The author had rightly said, and the same thing had been hinted at by Mr. Turnbull, that the proper use of museums should be taught, but the museums should not be regarded as places in which to " pinch " ideas and parade them as one's own. The schools of art, nevertheless, should use the museums more than they did. After all, there was nothing absolutely original; every worker took something here and something there, and coloured it and mingled it to express himself. Certainly if the schools would send their students into the museums it would be more useful for the manufacturer. He believed that the enterprising manufacturer was only too willing to help the student or the apprentice who was himself willing to help the manufacturer. There was no limit to what might be accomplished by the young designer or the artist, once he had got the confidence of the manufacturer or his employer. The artist was of use in industry. Probably the author was not aware of the work put into this competition scheme. Its organization had meant much work and self-sacrifice on the part of those who had attended the committees, which had met on very many occasions. The scheme was never intended as an alternative to or a substitute for the National Competition, and, moreover, as he understood it, it was meant for everybody, not those in schools of art only. In conclusion, he pleaded for an end of the antagonism between the schools and industry. Criticism to be of any value must be sympathetic. Manufacturers should not condemn the schools, for the schools really wanted the manufacturers' guidance.

Mr. E. R. Edis said that, speaking from the point of view of pottery and glassware, he felt himself very much in sympathy with what Mr. Baker had said. His considered opinion, after two years' experience of designs sent in from schools of art, was that there was a want of sympathy between schools of art and the manufacturers of the district in which they were placed. Designs were over-elaborated, those who produced them seemed to have no idea of the cost, and some of them were almost impossible. In his committee they had had the co-operation of one of H.M. art inspectors, and at the last meeting of the committee, attended by some of the most representative men in the trade, they had an opportunity of placing their views before him rather strongly. Though the members of the committee felt that the schools were on theoretical rather than practical lines, there was no antagonism on the part of the manufacturers, who would be only too pleased if the directors of art schools would get in touch with them. If a promising art student got an appointment as designer to a manufacturer and remained with him some little time, he got to know what was required by that particular branch of industry, and then the difference between his views as to design and those of the art school from which he came was manifest in a remarkable degree. The manufacturers would only be too pleased if the art school masters would make a note of their views, and he thought H.M. Inspector would take the opportunity of conveying the ideas of the committee to the art school over which he had control.

Mr. W. G. Raffé, commenting upon some of the work which the author had shown them, said that although it reached a very high standard as school of art work, it was not industrial art—it was "art-and-craft" work. Out of all the examples which had been shown on the screen, ouly those relating to books and textiles were

suitable for industrial use. He thought—rather contrary to something that the author had suggested—that things which were the outcome of mass production, such as a Ford car, an aeroplane, a typewriter, a common china mug, all lent themselves to good design, but all of them must be conceived from the beginning in the terms of the mechanical process in which they were to be made. That was what the art school could not provide. The idea that the schools of art should provide manufacturers with ready-made designs, as the manufacturers optimistically hoped, was bound to be frustrated. There was in the Society's Competition a noteworthy difference from the National Competition in the absence of all studies made in preparation for the designs. It was his own experience as a student to be rather wanted to carry on studies to a degree that was nauseating. He had to make studies for studies' sake. Studies were all right for local exhibitions, but manufacturers had no use for them. The ability to draw was a craft, and not the end of the artist. The artist was such because he was a creative designer. The advice was often tendered, " Go and study Nature," but what "Nature" was they were very seldom told. He thought it would be better to say, " Have 10 per cent. Nature study and 90 per cent. museum study," and by museum study he meant—not stealing ideas—but seeing how . . . the other fellow did the job. But, of course, in museum study there must always be at the back of the mind the idea that most of the things in museums were hand-products, while most of the things in industry were machine-products. It was also stated that the student needed to "express himself." That was a fallacious doctrine. He should be taught not to express himself but to do what was wanted. The necessary thing was a little more discipline and a little less "self-expression." He had been very glad to hear Mr. Baker emphasize the importance of colour. He had been often sorry to notice the absence of colour instruction in the schools. In most of the schools any scientific colour instruction was remarkable for its absence. The same might be said regarding formal geometry as a basis of design. It was hardly studied. Finally, he would like to offer a reply to Mr. Turnbull when he said that he had "no use for schools of art." Mr. Turnbull might be a producer of textile goods, but the schools of art—at least he hoped so—were producing discriminating buyers of textile and other goods, and would go on producing them.

Major A. A. Longden said that he entirely agreed with Mr. Baker's remarks, and with those of the last speaker. There was at the moment a great gulf dividing the schools from the manufacturers, as had been shown by the author on the one hand and by Mr. Turnbull on the other. If nothing else could be done, surely there might be some liaison established with a view to connecting up those on either side of that gulf. Some in that meeting might be in a position to agree with almost everything that had been said that night, and yet the gulf remained. He wondered whether any register of former graduates had been kept in any school showing in what way they had been absorbed in the industries of the country. He had asked the head of one of the leading schools, and had been informed that there were no such records. The students had left and had been absorbed and lost sight of. He wondered whether this was the case at the Manchester school. Finally, he hoped that Mr. Turnbull would change his mind about schools of art, and that Mr. Dawson would see if anything could be done to fill the possible gaps as suggested by Mr. Turnbull.

Mr. Turnbull interjected that he was not opposed to art training, and indeed that he had been instrumental in furthering it on various occasions. His objection

was to the present method of art school training for students intended for industry

The Chairman, in closing the discussion, said that the Society owed a debt of gratitude to the author of the paper, who must have spent great pains upon its preparation. He would like heartily to endorse what had been said with regard to co-operation between the manufacturers and the art schools. It was also very necessary to establish co-operation between industry and the artists themselves. In France this was done, to the great advantage of French artistic production. The Royal Society of Arts had invited a certain number of artists and a certain number of manufacturers to joint conference, and there was a most interesting exchange of views. In the many addresses which he himself had given to art schools, he had taken occasion to say very nice things about them, and in a practical way he supported the schools, because he had no other designers in his mill than those who had been trained in the schools. He called upon the audience to give a hearty vote of thanks to the author of the paper.

Mr. J. A. Milne, C.B.E., seconded the vote of thanks.

Mr. R. A. Dawson, in replying, after acknowledging the compliment, said, that owing to the lateness of the hour he could not attempt any full reply on the many points raised in the discussion. As he had already said, he had felt it somewhat audacious on his part to put before the Society the things he had put before it and to criticise its competition scheme. He only did so because he was asked to do so. If the paper served the purpose of making those who had heard or would read it think a little further along this question, he would be quite satisfied. Sir Frank Warner had mentioned co-operation, and that was the keynote of all that he (the speaker) had tried to say. More co-operation was wanted, not merely by way of joint committees, but through the assistance which sympathetic manufacturers might render to schools of art. The kind of co-operation he had in mind was not a spasmodic effort, but a constant good will. Mr. Baker had raised the question of advisory committees. At Manchester in the art school they were doing all that they could to get into touch with industry. They had an advisory board, and on that board they had representatives of all the most important industries. When they took up any further study in the school they were careful to get in touch with the leaders of that particular industry. They were just about to introduce cabinet-making, they had classes at present for furniture designers and wood carvers, and a few of the things that grouped themselves around cabinet-making, but they were going to go further; and at the last meeting of their advisory board the question was under consideration as to who should be invited to go on to that board to represent industrially this new subject. With regard to museums, they were fortunate in having a museum in connection with the Manchester School of Art, and it proved very useful; his only trouble about it was that it took up so much space, and the school was badly in need of more space on account of its continual advance—the present number of students was 1,100. But the museum helped to feed or stir the imagination of the students. Of course, one difficulty with regard to museums was the comparative absence of modern examples. It was necessary to show the student what it was possible to do now. In contradiction to the advice of the French and others, that what was wanted was Nature study, Mr. Raffé had declared that there was too much Nature study. But he (the speaker) thought it necessary to couple the student's Nature study with his study of historic work or of good modern work. In his view, all schools of art believed

in the practical side, and wished to have the means of giving practical instruction. In his own school it was arranged that the student by way of definite instruction should have the benefit of the experience and knowledge of the people who had gone on before. He did not want to suggest that education was standing still. It was ready to go forward still further if this closer co-operation with industry could be brought about. He believed that that co-operation would be effected by each industry, whose technique was represented in the instruction given in the school, being represented on advisory committees and taking its share in looking after its own people so as to ensure that they got the advantage of the training which the school could offer. He felt that the manufacturers must take such a line as this, even from the point of view of getting value for their rates and taxes. Such co-operation would have to take place to a greater extent in the future.

Something had been said about colour schemes. He desired to point out that in the lantern-slides of the work which he had shown the photographer had had to leave out colour, and therefore it was only the inadequate monochrome impression of this work that the audience had seen. But colour schemes entered largely into the instruction given in the school of art, and in the case of the textile designs the slides did not show the set of five or six alternative colour schemes which appeared beneath the actual designs; these would have indicated that the school was trying to do what the manufacturers wanted doing. A point to be considered with regard to colour schemes was this, that it sometimes happened that there was no sale for the scheme of colour the artist had arranged in his design and so that scheme was never produced. The middleman in some cases discussed the matter with a prospective buyer, and so the colour scheme was altered, and the good scheme of colour which the artist had thought out had no chance at all. He had known the middleman, who had had no artistic training, to write down the colours which had been agreed with the buyer, and then go to the works with the written statement of the changes that were to be made to suit the buyer's taste. In Manchester, they were trying to remedy that kind of thing through the provision of courses of training for salesmen and saleswomen in the wholesale and retail textile distributing trades. With regard to Mr. Turnbull's invitation, he would be very pleased to go and see Mr. Turnbull's works, but he hoped that Mr. Turnbull also would come and see the school of art. With regard to Major Longden's point about records, some schools had suffered in the past through not having them, but a proper register was now being kept, so far as this was possible, of the whereabouts of old students. Again he wished to thank the Society for the kind way in which it had received the paper.

Mr. W. G. Raffe writes :—

Many points raised remain unanswered, and many other points were not mentioned that seemed to be important. The whole aim of the R.S.A. competition is presumably to stimulate the production of industrial designs for a precise purpose. The foundation of our art schools was as "schools of design." As schools of fine art or commercial art—much the same thing nowadays—they were not intended. As between giving a general training to young people who require a cultural knowledge of art as part of education, and a specialised training to designers for some specific industry there would seem to be no essential conflict between art school policy and that of this competition. Why does a purely industrial competition and exhibition conflict with art school work, any more than the purely pictorial work of the R.A. and other exhibitions, all with hope of eventual sales?

Manufacturers, as other employers, are inclined to expect too much of schools in

general, and art schools in particular. No student can leave school immediately fit to " cope with industrial problems." The manufacturer himself never did so, nor will his own son. But, in addition to students being invited to submit designs the buyer must be willing to survey them rather as indications of general than specific ability, with the possibility of giving a further period of training in contact with actual conditions.

The best training for design—which is all that matters in the long run—is the practice of designing for a very definite and known purpose, such as is demanded in all industrial work. Making studies, or learning to draw, can easily be adjusted within this process, normally and quickly. The manufacture of elaborate " testimonies of study," merely to prove ability, is a roundabout method of little educational and no industrial value. The imposed discipline of such compulsory study should be replaced by the artistic self-discipline of an intelligent, acceptable purpose in all work.

It is impossible to design adequately for industrial purposes unless acquaintance with manufacturing processes has been gained, preferably with some knowledge of markets in addition. Equally it is impossible for a manufacturer to get the best possible designs unless his own man has had an art training. Even those who can make designs without it would be far better with it. The principles of form and colour must be linked with the principles of production and sale, which in one individual will produce the most competent designer. The best industrial design is that which supplies the market by exploiting the productive processes to the greatest degree consonant with increased efficiency in the function of the object made, adding to its sale value without adding to its cost in the same proportion. Handicraft design, however good, is here of relatively little value, except as preliminary training in craft technique and in application of design knowledge to definite purpose, under immediate control. The principles of design can be taught in the abstract, though not so speedily, but industrial design must always be definite and precise in application, and accurate in intention and purpose.

The standing of an industrial designer will obviously depend on his work, and not on certificates. Gold medals in the National Competition had little attraction for design buyers. The appeal to purchasers may be by form and colour, but unless economical production intervenes, costs are often too high. Design methods must control production, and production must control certain phases of design, mutually.

The same applies to teachers, but unfortunately only steady " jobsters " are wanted in schools. A man who leaves teaching to enter industry is seldom wanted as a teacher again, even though knowing more of what should be taught. As the industrial designer needs industrial training, so does the art teacher who is to train him in design. This cannot be done merely by inviting specialist technicians into the schools, when they have no experience in the difficult art of teaching, and often none of design principles. The best design teacher is one who has had both workshop and art training, capped by a good education, before or after. The best competition to develop industrial design is without doubt one that requires work for a purpose, provided there is scope for imagination and invention, exclusion of imitation, and adequate rewards for work done, in prizes, publicity, and commissions.

ECONOMIC CONDITIONS IN LATVIA.

Latvia is a Republic governed by a President elected for a term of three years, a single Chamber Parliament (Saeima) elected for three years, and a Cabinet of Ministers. It was formerly a part of the Russian Empire, and commenced its

existence as an independent State in 1918 under conditions of great difficulty. In his Report on the economic and industrial conditions in Latvia, H.M. Consul at Riga points out that during the first two years of the new State's existence unstable political conditions and a steadily falling exchange were serious handicaps to economic progress, and business decreased, but in 1921 the stabilisation of the currency, and changes in the economic policy of the Government which accompanied a return to peace conditions led to a revival in business. It must, however, be remembered that in a small agricultural country the possibilities of trade expansion have very definite limitation, and that the difficulties of Latvia's economic position are enormously increased by the stagnation of trade and industry in Soviet Russia.

Occupying an area of some 65,000 square kilometres, with frontiers touching on Esthonia, Russia, Poland and Lithuania, Latvia is divided into the four administrative districts of Livonia, Latgallia, Courland and Zemgallia. The country is sparsely populated, and the inhabitants have decreased from 2,552,000 in 1914 to 1,900,000 at the present time, 76 per cent. being rural dwellers. The capital and seat of government is Riga with 285,000 inhabitants as compared with 520,000 in 1914, the only other towns with more than 10,000 residents being Libau (79,000), Windau (15,000), Dvinsk (36,000) and Mitau (15,000). These figures are taken from the census of January, 1922, but no marked change has taken place since that date; immigration has almost ceased, and the surplus of births over deaths is small.

In pre-war days Latvia was well developed industrially, but as its factories were established to produce goods for Russia they are now unnecessary, and for the most part have not restarted operations. Latvia is essentially an agricultural State, and the policy of the Government is directed principally to encouragement of agriculture, but though the area under cultivation has increased greatly during the last few years, there is less land under corn than formerly, and it is necessary to import both rye and wheat in ever growing quantities. In 1923 the harvest was a failure owing to the very wet summer, and in 1924 it was barely average. The prospects for 1925 are not very favourable as the mildness of the winter will have a bad effect on winter sowings. It is very generally believed that Latvia's future lies in the development of dairy farming on Danish lines, more especially so as the land, under the operations of the Agrarian Act of 1920, is now split up into small holdings. Dairy produce already occupies third place in the list of expots.

Prior to the war the Latvian ports handled a very large share of the imports and exports of Russia, and after the conclusion of peace it was hoped that this position could be regained. Large stocks of goods were despatched to Latvia in 1919 and 1920, and many people commenced business in the hope of sharing in a profitable trade with Russia; unfortunately, this expectation has not been realised, and the present small transit trade with Russia shows little prospect of great expansion.

According to the trade returns, Germany supplied 45.09 per cent. and the United Kingdom 16.32 per cent. of the imports into Latvia. Of the exports from that country, the United Kingdom took 42.01 per cent., the other principal buyers being Belgium with 18.49 per cent. and Germany with 15.90 per cent.

Germany's preponderance in the Latvian market is unsatisfactory from the point of view of the British manufacturer, and can be traced in some measure to the natural reluctance on the part of British exporters to grant long credits. German costs of production are in nearly all lines lower than those of United Kingdom manufacturers, and Latvian buyers are almost entirely guided by price irrespective of quality.

The principal imports into Latvia are foodstuffs, textiles and machinery, followed by chemicals, coal and coke, metals and pharmaceutical goods.

The exports from Latvia are chiefly timber and flax, though the output of dairy produce is steadily increasing.

EAST AFRICAN INDUSTRIES.

The Report for the year ended 30th September, 1924, on the trade and commerce of East Africa (Uganda Protectorate, Kenya Colony and Protectorate, Zanzibar, and the Tanganyika Territory) by Colonel Franklin, His Majesty's Trade Commissioner in East Africa, contains particulars of the local industries of the various sections of the Colony, from which the following is taken :—

SUGAR. Mention was made in the previous year's report of the erection of a sugar factory near Jinja, in Uganda, which will shortly begin working. Another, though smaller, is now in operation at Muhoroni, in Kenya Colony, which, together with the factory at Miwani and that at Ruiru, both in Kenya Colony, should, when in full production, much more than supply the home market furnished by Uganda, Kenya, Tanganyika and Zanzibar.

Practical interest in sugar manufacture on a large scale has been taken further. A group of Mauritius sugar planters have, it is understood, following the visit of a delegation to Kenya, taken steps to open negotiations for land for sugar planting, and other groups are reported to be evincing more interest in the production of sugar for export.

It is recognised that there are large areas at the coast and other districts of Kenya and Tanganyika capable of growing a vast amount of cane, and the growing importance of East Africa as a world's supplier of sugar can confidently be predicted. It is yet to be proved that the lake areas and Uganda will be able to take advantage of the large tracts of land suitable for this crop owing to their distance from the coast.

WATTLE EXTRACT. The factory to produce wattle extract at Limoru is now in working order and some 100 tons are reported to have been exported.

LEATHER. A reorganisation of the factory for the production of leather at Tsavo has been completed and it appears it will soon be necessary to find export markets for its surplus production.

BEER, ETC. The local brewery near Nairobi continues to make good progress and the quality of the output is improving rapidly.

TOBACCO. More interest is being shown in tobacco growing in the area, especially in parts of Tanganyika. The local product in that territory, though as yet small in quantity, compares with Rhodesian varieties and finds a ready local market.

TEA. Another line with great possibilities is the local growing and manufacture of tea. An important tea-growing firm has recently acquired land at Limoru for this purpose, and will, moreover, be able to take over for manufacture the tea grown by surrounding planters. Other promising enquiries from responsible quarters are also reported.

CEDAR SLATS AND BAMBOO PULP. The production of cedar slats for pencil making is increasing, and with careful fostering in such matter as selection and preparation, should provide a large export trade in the future. Developments may be expected in the exploitation of bamboo forests for the preparation of pulp for the manufacture of paper. The large forest concession at New Hornow on the Tanga Railway has been acquired by a syndicate which hopes to promote a large industry there.

CANNING. The Uplands bacon factory in Kenya Colony is extending its operations and is canning products which find a ready sale in the local markets. The Governments, through their veterinary adviser, are making further attempts to induce home capital to take a practical interest in the possibilities of a meat export industry.

DAIRY PRODUCE. The possibilities of the dairy produce home and export trades have not been overlooked. A full examination of the possibilities of the export of butter, cheese and allied products, has been conducted by the Economic and Financial Committee in Kenya, with the result that a sum of £25,000 has been set aside to provide cold storage at the coast in connexion with the new pier, and this, with refrigerator vans on the railway, should provide the stimulus for the erection of a series of creameries at appropriate centres inland.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MAY 17.. Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. General Meeting.

East India Association, at the Caxton Hall, Westminster, S.W. 3.30 p.m. Rev. C. E. Wilson, "The Lay Work of Missions in India."

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Dr. F. Dixey, "The Nyasaland Section of the Great Rift Valley."

Victoria Institute, Central Hall, Westminster, S.W. 4.30 p.m. Dr. Alfred T. Schofield, "Religion and Science."

University of London, at King's College, Strand, W.C. 5.30 p.m. Baron A. F. Meyendorff, "Russian Thoughts on Problems of Ethics." (Lecture III).
5.30 p.m. Dr. Otakar Vocadlo, "The Place of the Czechs in the Slavonic Family." (Lecture III).
5.30 p.m. Dr. Hubert Hall, "Some Aspects of Diplomatic Study." (Lecture II).
5.30 p.m. Mr. Henry Wickham Steed, "Central Europe and the Peace." (Lecture II).
5.30 p.m. Le Père Delehaye, "l'Histoire du Culte des Saints dans l'Antiquité." (In French). (Lecture III).
5.30 p.m. Dr. C. D. Broad, "The Present Position of the Logic of Induction."
At University College, Gower Street, W.C. 5 p.m. Prof. G. Dawes Hicks, "Hegel's Aesthetics." (Lecture III).
5 p.m. Mr. G. N. Clark, "Modern English Historians: (III) Macaulay."
5.30 p.m. Prof. Dr. J. B. Collingwood, "The Influence of Water on Vital Processes." (Lecture VI).
At the Imperial College, Royal School of Mines, South Kensington, S.W. 5.15 p.m. Prof. Sir T. W. Edgeworth David, "Past Ice Ages of the World." (Lecture III).
At the London School of Economics, Aldwych, W.C. 5 p.m. Mr. William Cash, "Published Balance Sheets."

TUESDAY, MAY 18.. Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. Michael Terry, "Some Little Studied Aborigines encountered during Travels in North Australia."

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. W. S. Burn, "Double Acting Oil Engines."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. G. W. C. Kaye, "The Acoustics of Public Buildings (Lecture II).

Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m.

Transport, Institute of, at Savoy Place, Victoria Embankment, W.C. 0.00 p.m. Lecture.

University of London, at King's College, Strand, W.C. 4.30 p.m. Prof. Dr. R. J. S. McDowall, "The Integration of the Circulation." (Lecture IV).
At University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. G. E. Moore, "Universals and Particulars." (Lecture III).

WEDNESDAY, MAY 19.. Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Messrs. M. Thompson, R. H. Dudderidge, and J. G. A. Sims, "Life-Testing of Small Thermionic Valves."

Geological Society, Burlington House, W. 5.30 p.m. 1. Mrs. Jane Longstaff, "A Revision of the British Carboniferous Murchisoniidæ, with Notes on their Distribution and Descriptions of some New Species." 2. Mr. Neville George, M.Sc., "The Carboniferous Limestone (Avonian) Succession of a Portion of the North Crop of the South Wales Coalfield."

Metals, Institute of, at the Institution of Mechanical Engineers. 8 p.m. Prof. H. C. H. Carpenter, F.R.S., "Single Metallic Crystals and their Properties."

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m.

University of London, at University College, Gower Street, W.C. 5.30 p.m. Prof. Didrik Arup Seip, "Norwegian, a Language in the Making." (Lecture III).
At the London School of Economics, Aldwych, W.C. 5.15 p.m. Mr. A. Cathles, "Accounts, Straightforward and Misleading."
5.30 p.m. Prof. P. J. Noel Baker, "Practical Problems of Disarmament, Lecture IV, Air Forces and Chemical Warfare."
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. The Rev. Arthur S. Cripps, "The Wanjanja, Wanhera and Neighbouring Tribes." (Lecture III).

THURSDAY, MAY 20.. Chemical Society, Burlington House, W. 8 p.m.

Mining and Metallurgy, Institution of, Burlington House, W. 5.30 p.m.

Royal Society, Burlington House, W. 4.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Mr. U. R. Evans, "Corrosion of Metals."

University of London, at University College, Gower Street, W.C. 5.30 p.m. Dr. A. M. Bassani, "Edmondo De Amicis." (In Italian).
At the Imperial College of Science, South Kensington, S.W. 5.30 p.m. Air Vice-Marshal H. R. M. Brooke-Popham, "Air Warfare."

FRIDAY, MAY 21.. Royal Institution, 21, Albemarle Street, W. 9 p.m.

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. J. A. K. Thomson, "The Development of Irony." (Lecture I).
5.30 p.m. Dr. F. S. Boas, "The Play within a Play."
At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. E. Beddington Behrens, "International Problems of Industry." (Lecture IV).

SATURDAY, MAY 22.. Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. G. C. Simpson, "Atmospheric Electricity." (Lecture II).

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FRIDAY, MAY 21st, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

FUND FOR PURCHASING THE SOCIETY'S HOUSE.

The following contributions to the fund for purchasing the Society's House have been received since the last list was published in the *Journal* of March 12th, 1926:—

	£	s.	d.
Amount previously acknowledged	43,069	7	5
Messrs. Cadbury Bros., Ltd.	100	0	0
Viscount Inchcape, G.C.S.I., G.C.M.G., K.C.I.E.	100	0	0
Sir Robert M. Kindersley, G.B.E.	25	0	0
Sir Charles H. T. Metcalfe, Bt.	25	0	0
Orlando Henry Wagner, Esq., M.A.	10	0	0
Cedric Chivers, Esq., J.P.	5	0	0
William Rushton Parker, Esq., M.A., M.D....	5	0	0
Sir Cecil Reeves Harrison, K.B.E.	3	3	0
Walter Woodbine Parish, Esq.	1	0	0
	£43,343	10	5

Fellows of the Society are reminded that the amount aimed at by the Council is £50,000, which, in addition to purchasing the freehold, will cover the cost of renovating and decorating the House.

REPRINT OF CANTOR LECTURES.

The Cantor Lectures on "Coal Ash and Clean Coal," by R. Lessing, Ph.D., M.I.Chem.E., have been reprinted from the *Journal*, and the pamphlet (price 2s.) can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A full list of lectures which have been published separately and are still on sale can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

INDIAN AND DOMINIONS AND COLONIES SECTIONS.

(Joint Meeting).

FRIDAY, APRIL 16TH, 1926.

MR. ARTHUR MICHAEL SAMUEL, M.P., Parliamentary Secretary, Department of Overseas Trade, in the Chair.

THE CHAIRMAN, in introducing Lieutenant-General Sir William T. Furse, pointed out that in 1923 a Committee of enquiry had recommended the appointment, as Director of the Imperial Institute, of a purely administrative officer who was not a scientist. They had been extremely fortunate in securing for that position such a man as Sir William Furse, whose name was well known as that of one of the most distinguished Officers in the late war, in which he had commanded the Ninth Division; since his retirement he had held a responsible position under the Ministry of Pensions, and had subsequently assisted the Department of Overseas Trade in connection with the Wembley Imperial Exhibition. He organised the Pageant of Empire, and had been a leading spirit in one of the most successful things that had been shown at Wembley, the Military Tattoo. He had the habit, which was not uncommon among Englishmen, of making a success of everything he put his hand to.

The following paper was then read :—

THE WORK OF THE IMPERIAL INSTITUTE.

By LIEUTENANT-GENERAL SIR WILLIAM T. FURSE, K.C.B., D.S.O., Director of the Imperial Institute.

THE HISTORY OF THE INSTITUTE.

The Imperial Institute has passed through several phases since it was founded in 1887, on the initiation of King Edward VII., when Prince of Wales, to commemorate the Jubilee of Her late Gracious Majesty Queen Victoria. It was the outcome of the combined efforts of the people of the United Kingdom, of India, and of the Dominions and Colonies, which resulted in subscriptions being forthcoming for the erection of the great buildings at South Kensington and the formation of an endowment fund.

Through all its various phases one main idea has never been lost sight of, that of making the Institute a centre and clearing house for information, investigation and exhibition of the natural resources of the Empire, in order to promote inter-Imperial commerce and industry.

The first corporation, which was granted a Royal Charter, founded the Exhibition Galleries, set up an Investigation Department with research laboratories, and issued a quarterly publication, known as the Bulletin. The Institute was made a place of popular resort, and there was founded what amounted to a club provided with luncheon and dining rooms, concerts and periodical exhibits.

In the year 1900 the social side was abandoned and the building and the invested funds were transferred to H.M. Government, who leased the western part of the building and the Galleries to the Institute, and the eastern and central portion to the University of London.

Until the end of 1902 the Institute was managed by a Governing Body of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was the first President, being succeeded by H.M. King George V. when Prince of Wales. There was also an Executive Council. But thereafter the management was transferred by Act of Parliament to the Board of Trade, assisted by an Advisory Committee. In 1916 the property and management was handed over by Act of Parliament to the Secretary of State for the Colonies with an Executive Council.

In 1920 and the following years, the Institute was in considerable difficulty as regards finance and the Duke of Devonshire, then Secretary of State for the Colonies, set up a Committee of Enquiry in 1923, under Mr. Ormsby Gore as Chairman, to consider and report

" (i.) What functions at present carried on by the Institute are considered " essential, and

" (ii.) Whether these should be continued by the Institute or attached elsewhere."

This Committee reported in the same year and their very full report was considered by the Imperial Economic Conference in October, 1923.

The resulting arrangements were embodied in an Act of Parliament entitled " the Imperial Institute Act, 1925." This Act authorized the amalgamation of the Imperial Mineral Resources Bureau with the Imperial Institute, transferred the parliamentary control of the Institute to the Department of Overseas Trade, and provided for its management by a Board of Governors representing the various interests concerned, and for the continuation of the Exhibition Galleries. The decision to continue the Galleries was facilitated by Lord Cowdray generously promising £20,000 spread over five years.

In pursuance of the provisions of this Act, the amalgamation with the Imperial Mineral Resources Bureau has been carried out; the control of the enlarged Institute has been transferred from the Colonial Office to the Department of Overseas Trade; the new Board of Governors has been set up; and the work of re-organization has been pushed forward.

Such, very briefly, is the history of the Imperial Institute up to the present time.

THE PRESENT ORGANIZATION.

The Imperial Mineral Resources Bureau and the Imperial Institute having been amalgamated, the erstwhile Imperial Mineral Resources Bureau has become the Mineral Resources Department of the Institute. The Board of Governors is presided over by the Parliamentary Secretary of the Department

of Overseas Trade, the Vice-President being the Comptroller-General of that Department. This Board is composed of the High Commissioners representing the Dominions and India, representatives of the Treasury, Board of Trade (including the Mines Department), Colonial Office, Ministry of Agriculture, and the Department of Scientific and Industrial Research, a representative of the Royal Society, of the Association of British Chambers of Commerce, of the Federation of British Industries, and of the Royal Botanic Gardens at Kew, and, in addition, there are a number of persons representative of scientific and commercial interests.

The Board has delegated the more detailed supervision of the Institute's administration and finance to a Managing Committee of eight members, which meets monthly under the Chairmanship of the Comptroller-General of the Department of Overseas Trade.

The primary work of the Institute, viz., Information and Investigation, is dealt with under two main divisions, viz., (1) the Mineral Resources Department, and (2) the Plant and Animal Products Department. To each of these are attached well-equipped chemical laboratories, each department being divided into an intelligence section and a laboratory section.

The Board of Governors have further appointed a Laboratory Committee in accordance with the recommendation of the Imperial Economic Conference.

In connection with each Department of the Institute is an Advisory Council, the one considering and advising on mineral and metallurgical matters, the other on vegetable and animal products. These Councils are composed of persons of outstanding eminence in their respective spheres of activity and are presided over by Chairmen who are also experts. Under these Councils are Advisory Technical Committees.

The Work of the Institute in Connection with Minerals.

The scheme of work undertaken by the Institute in connection with minerals may perhaps be best described as relating to (*a*) Intelligence and publications, (*b*) Laboratory investigations, and (*c*) Legal. (*a*) *Intelligence and publications* comprises the collection of information as to *Resources*, under which term is included such matters as (1) location, extent and character, treatment and transport, (2) annual and other periodical statistics, dealing with production, consumption, exports, imports, prices, etc. The work of this section consists in the preparation of reports and replies to inquiries relative to mineral matters.

(*b*) The work performed in the laboratories is the examination and analysis of mineral samples submitted to the Institute for investigation, ceramic work—especially the analysis of pottery clays, the examination and carrying out of tests—physical as well as chemical—on cements and building stones and the examination of the mineral contents of soils.

(*c*) The legal section has done excellent work in the compilation of a digest of the Mining Laws and Regulations of the British Empire and in regard to

inquiries of a legal nature which have been addressed to this body from time to time by Government Departments and others, chiefly relative to draft prospecting and mining regulations or to mineral concessions.

It will be realized that in the carrying out of work such as this an extensive and thoroughly up-to-date reference library is of the greatest importance and such a library exists at the Imperial Institute.

Indeed, a library of perhaps the most up-to-date *current* mining and metallurgical literature has been formed, comprising, *e.g.*, the official reports of the mining, geological and statistical departments of the Imperial Government, and of the Governments of the Dominions, India, the Colonies, Protectorates and Dependencies and of foreign countries, reports of Companies, current scientific, technological and trade periodicals and standard works. I should state that the library is open for purposes of consultation to the public free of charge.

An important function imposed upon this Department is that of disseminating information relative to minerals and metals which it receives from official and unofficial sources. It has for long been careful to disseminate only such information as it has received from authoritative sources. This is done through the Institute's publications, the public press and the trade organizations concerned where they exist; in the absence of a trade organization the matter is brought before the relevant Advisory Technical Committees, which act under the Advisory Council on Minerals, and advise, *inter alia*, as to the manner in which the information should be brought to the attention of those likely to be interested. Each Government within the Empire is informed, through the Corresponding Members of the Mineral Resources Department of which there is one in each Dominion, Crown Colony and Protectorate, and in each Province in the case of Canada. The Advisory Council dealing with mineral resources is composed of experts and others connected with the mining and metallurgical industries, with geology and with mineralogy. On this body also are representatives of the Dominions and Colonies. The duty of this Council consists in advising the Imperial Institute as to the collection, co-ordination and dissemination of information relative to mineral resources; their production, treatment, consumption and requirements; and as to the development of such resources within the Empire, or particular parts thereof, in order that such resources may be made available for the purposes of Imperial defence or industry or commerce. The Council is presided over by Sir Richard Redmayne, eminent as an expert in mining and minerals.

The Chairman of the Council, in addition to his office as such, acts as a consultant or adviser to the Imperial Institute on all matters connected with minerals and for that purpose is available for consultation by myself, as Director of the Institute, at all times, being in daily attendance at the Institute.

With the object of securing the best possible advice on all matters connected with minerals and metals, these have been divided into groups and an Advisory

Technical Committee established to deal with each. Of these Committees, which have been in operation for six years, there are fifteen, comprising in the aggregate 152 persons. Each Committee is under the Chairmanship of a member of the Advisory Council on Minerals, so that there exists the closest possible liaison between the Council and the Advisory Technical Committees.

The scope of the duties which was mapped out for these Committees and the lines along which they have worked, may be stated as follows :—

(i) The general consideration of the different mineral resources, together with their various forms, mode of occurrence, treatment, products therefrom, and uses.

(ii) Sources in the British Empire and Foreign Countries.

(iii) Concessions and conditions attaching thereto.

(iv) Export duties, royalties, etc.

(v) Customs and import duties of different countries.

(vi) Statistics and the best form in which to collect and publish them, as regards :—

- (*a*) Output.
- (*b*) Production.
- (*c*) Cost of production.

(vii) Price and freight rates.

(viii) Basis of sale or purchase.

(ix) Treatment (local treatment, if any).

(x) Future production, ore in sight, etc.

(xi) Consumption in the British Empire and Foreign Countries, and for what purposes. The probable future consumption and trend of prices.

(xii) Experimental and research work, whether desirable, and, if so, how it should be set about.

These Committees constitute a most important feature in our organization, comprising, as they do, some of the leading authorities on the respective minerals and the industries connected therewith. The assistance which they have rendered to the Mineral Resources Department has been very great indeed. I cannot pay too high a tribute to their patriotic voluntary work.

THE PLANT AND ANIMAL PRODUCTS DEPARTMENT.

This department comprises, similarly to the Mineral Products side, an Intelligence and a Laboratory section. There is an Advisory Council, lately set up, on Plant and Animal Products consisting, at present, of 14 members, persons eminent in their knowledge relating to various products, e.g., silk, timber, rubber, cotton, other fibres, paper making materials, oils, oil seed, tanning materials, wool and hides, foodstuffs, tobacco, drugs, gums and resins. The function of this body, like that of the Advisory Council on Minerals, is to advise the Imperial Institute on all matters connected with the plant and animal products of the British Empire. It is presided over by the eminent

economic botanist, Sir David Prain, whose great services to botany, both in India and at Kew, need scarcely be stressed in such a company as this. He acts as consultant or adviser to the Institute on the matters which come within the purview of his Council and for that purpose his advice and help are always available to me, as Director.

Perhaps I might indicate more closely the nature and extent of the work of this side of the Institute by reference to its activities in respect of such commodities as rubber, silk and timber, for each of which there already exists a very strong committee of experts who meet frequently and deal very closely with the work coming within their particular priovinces. I should like to express the real indebtedness we are under to these committees. Their help is of the very greatest value to the Institute, their work beyond praise.

Rubber.—The Imperial Institute has been engaged upon rubber research for Ceylon since 1913, the investigation work being carried on at the Institute by a staff appointed and supervised by the Ceylon Rubber Research Committee, under the Chairmanship of Mr. Burgess, the cost of this work being defrayed in part by the Government of Ceylon and in part by the Rubber Growers' Association and Ceylon Rubber Estates. There are on this Committee representatives of the Rubber Growers' Association, Ceylon planting interests, and rubber manufacturers, including a nominee of the Research Association of British Rubber and Tyre Manufacturers.

The Institute has a long experience of work in connection with rubber and it possesses ample facilities for investigation on rubber and a specialised staff dealing solely with problems relating to raw rubber.

In view of the interest taken in rubber in other parts of the Empire besides Ceylon—particularly Malaya—it seems eminently desirable that the scope of the Committee should be extended so as to include Malaya certainly, if not other important parts of the Empire where rubber is cultivated and possibly the Committee might be strengthened by the addition thereto of representatives of other rubber interests.

Questions other than vulcanisation, on which much work is carried out at the Institute, are now assuming great importance in the industry, e.g., the physical properties of raw rubber, and special apparatus has been devised and installed at the Imperial Institute to investigate these problems. These and similar questions are of equal importance to all rubber growing countries within the Empire and it would be a great advantage to deal with them in a central laboratory in this country in close association with manufacturers.

Silk.—There is a strong Advisory Committee dealing with the subject of sericulture, or silk production, within the Empire. Its Chairman is Sir Frank Warner. I cannot speak too highly of the work which has been performed by him and his Committee in the past under difficult conditions as regards funds. Their work in regard to India and Cyprus is deserving of high commendation and should be recorded.

The Committee's inquiries and experiments indicate that there are a number of British countries, notably Kenya, Uganda, Jamaica and Iraq, where, with adequate encouragement, sericulture could be undertaken or extended with material advantage to the growers and to the industrial development of the country concerned.

It may be mentioned that the whole of the silk raw material used in Great Britain (worth over 2¼ million pounds sterling per annum) is imported, and that, on an average of recent years, no less than 94 per cent. of this is derived from foreign countries. The only countries of the Empire producing silk on a commercial scale are India and Cyprus, the former country supplying practically the whole of the silk of British origin, and it is of interest to learn further that the world's annual supplies of raw silk (amounting to about 70 million pounds) are not equal to the increasing demands of silk manufacturing countries, notably those of America which consumes 70 per cent. of the world's silk entering commerce.

The British Silk Research Association is represented on the Institute's Silk Advisory Committee. The work of the two bodies in no wise overlaps, but is complementary the one to the other. The former body is concerned with such technical matters as the degumming of silk, permanence of dyes under the effect of light, etc. Our work is concerned with the furtherance of the production of raw silk within the Empire. It will, I am sure, be interesting to know that, largely as the outcome of the patient but ceaseless work of this Committee, a filature is now being erected in Cyprus and "Cyprus Silk" of the highest quality, known as such for the first time in history, will be on the market within a few months from now and chiefly, I hope, if not altogether, used in England.

Timber.—The work of this section, which receives advice and guidance from the Advisory Committee on Timber, carries out current tests on timbers from the Crown Colonies, notably Ceylon, Nigeria and British Honduras. The Chairman of this Committee is Mr. Searles-Wood, Vice-President of the Royal Institute of British Architects.

Here again there is no overlapping of work with other institutions. Our procedure in the matter of tests conformed largely with the standard methods which have been elaborated in the United States of America and Canada, but there were some points in respect of which improvement was possible. We have now, however, after discussion with Mr. Pearson, the Director of the Forest Products Research Board of the Department of Scientific and Industrial Research, arrived at a complete working plan, including descriptions of tests and of material, which permits of the closest co-operation between the two bodies.

Our Advisory Timber Committee, including, as it does, architects, furniture and motor car body manufacturers, importers and brokers, constitutes a valuable medium for information and advice which on occasions would be, I believe, helpful to the Forest Products Research Board.

Other Raw Materials.—The Advisory Council are now setting up some further committees to deal specifically with certain other products. The nucleus of such committees is already contained within the Advisory Council on Plant and Animal Products.

OVERLAPPING.

It is the policy of the Imperial Institute to avoid all overlapping of functions with other existing bodies and to work in harmony with them. Where an organization exists, such as the Experimental Station of the Board of Agriculture, to give an example, we realize the benefit to the Institute which results from keeping in close touch therewith. Inquiries are received at the Institute from time to time as to the composition and value of soils, manure, cattle foods and as to crops, in regard to the investigation of which and the problems connected therewith the Rothamsted Experimental Station can be of the greatest service to the Institute. And so in regard to many other products, whether mineral or plant or animal, we solicit the assistance of existing agencies where such are available.

Similarly arrangements are now being made for linking up the Trade Commissioner service of the Department of Overseas Trade more closely with the work of the Institute than has been the case in the past.

PUBLICATIONS.

Prior to the amalgamation with the Imperial Mineral Resources Bureau the Imperial Institute used to publish a quarterly Bulletin relating to mineral, vegetable and animal products, the matter therein referring more particularly to vegetable products. The publication of the Bulletin is being continued in what we hope will be an improved and extended form, the mineral and plant and animal matter being kept separate, that is, contained in separate and distinct sections, as silk manufacturers, planters, forest owners, and those concerned with tobacco and agricultural products generally may not be particularly interested in minerals and mineral products and *vice versa*. This work, as well as the other publications of the Institute, is regularly supplied free to the Government Departments concerned in all parts of the Empire and is on sale at the Stationery Office at a moderate price. It contains papers on matters of interest in regard to various products—occurrence, value, method of treatment—giving the most up-to-date information thereon, and in addition thereto the latest news as to discoveries of minerals, reviews of recent books on economic resources, abstracts from the more important articles in the technical and trade journals, and statistics of production, consumption, exports, imports and value compiled by the Statistical Section of the Institute.

Some years ago the Imperial Mineral Resources Bureau undertook the compilation of a mineral conspectus dealing with the world as a whole. In Germany there existed an annual statistical report on the more important

metals, issued by the "Metallgesellschaft," Frankfurt-on-Main, and in the United States a more comprehensive publication "The Mineral Industry," to both of which frequent recourse was had by those connected with the mineral industries in these and other countries. But these works did not satisfy the requirements of the British Empire. We can confidently claim that the Mineral Conspectus which has been issued by the Mineral Resources Department of the Imperial Institute, covering as it does the whole of the world's mineral resources, does this in such a way as to bring into prominence the comparison of the Empire and the rest of the world, and is generally regarded as the most authoritative source of information on the world's mineral industry since the year 1913. This work is kept constantly up to date.

In addition to the above there is issued, by the Institute:—

An Annual Mineral Statistical Digest;

A Summary of the Mining Laws and Regulations relating to (1) the British Empire and (2) Foreign Countries;

and occasional publications on specific subjects.

None of the publications of the Institute is sold with a view to making profit, but for the sole purpose of disseminating reliable and important information on the resources of the Empire. Hence the prices are kept as low as possible.

THE EXHIBITION GALLERIES.

The Exhibition Galleries are at present closed to the public as it was found necessary to modernize the lighting and heating arrangements and the closing of the British Empire Exhibition at Wembley also gave us and the Dominions and Colonies a chance of modernizing and improving our exhibits—a chance which has been welcomed by the Board of Governors.

It is hoped that these Galleries will be re-opened, free, to the public by the Whitsuntide holiday, and I have every reason to think that our new method of arranging the exhibits will be more attractive and interesting than heretofore.

Briefly, our changes are on the following lines. In the past there have been a vast number of show cases filled with rows and rows of glass bottles, each containing what appears to the layman's eye exactly the same product, be it seed or cotton or oil, and other cases filled with different kinds of wool or fibre which all appear very much alike. Now the ordinary visitor is apt to pass these by with a hurried glance, hoping to come upon something more entertaining. The expert who really wants to examine the differences between these products, which are to him and his needs all-important, cannot reach his goal through two layers of glass—the glass of the case and the glass of the bottle inside—or merely through his eyes. Other senses, smell, touch, taste, may be essential. Accordingly, we propose to relegate a great many of these samples to a sample room in close proximity to our scientific staff and their laboratories, and the expert visitor to our galleries will be taken there and given every

practical assistance in his investigations. This does not mean that the public galleries will not exhibit these products. They will—but in a more attractive way. We believe you must first arrest the feet and the mind of the visitor before you can hope to instruct him. The best modern means of doing so is the diorama or model. Young or old, we are drawn to these willingly. Round these dioramas we shall arrange the exhibits to which they refer and through artistic arrangement and with the aid of maps, charts, photographs, and clearly printed notes, we shall give the visitor in an interesting form considerable instruction in the value, past, present and future, to the Empire of this or that commodity from this or that Dominion or Colony.

You will realize that this transformation cannot be completely effected by the time the galleries are re-opened. It is an immense undertaking and requires time and money for its full realization. But there is nothing like having a policy and an ideal to work to and I see no reason why these galleries should not become most attractive and interesting to the people of this country and to visitors to our Metropolis as an exhibition of the unsurpassed and inexhaustible treasures to be found in one part or another of our wonderful Empire.

As soon as we can find the necessary funds, the Board of Governors are most anxious to instal a cinema at the Institute, believing—as I myself do—that this would be a most effective additional means to bring before our people, young and old, the beauties, possibilities and responsibilities of their unique heritage.

For many years past we have had organized visits of school children to our galleries, and we have two lecturers attached to the Institute to give full and accurate information to these classes and to the general public. I have hopes and plans for extending the value of our galleries to the various schools in and near London and I am getting into touch with the Educational Authorities to this end.

How far more instructive geography and history lessons would be if they were always taught together! And surely the first step in any instruction is to stimulate the personal interest of the student in the subject.

The time and money spent in bringing the class to and from our Galleries would be more than repaid by the interest and desire to learn about this or that distant part of the Empire quickened in the child by such a visit.

I remember getting 30 or 40 small boys up to Wembley from a little Cadet Corps in Surrey, in which I am interested. After they had looked at that wonderful representation in the Government Pavilion of Sir Roger Keyes' attack on Zeebrugge, I made them read Captain Carpenter's book on that stirring adventure and set them an examination paper on it. Their papers were excellent and I am sure some at least quite enjoyed the examination.

Indeed, my aim is to make our Exhibition Galleries a permanent and effective "Wembley."

But, in addition to these existing activities which I have attempted to outline this evening, I cannot help thinking that in the Imperial Institute we have what should be a centre for many other Imperial interests. For some it is already used. For instance, courses of lectures arranged by the Colonial Office are frequently given in the Institute to young gentlemen about to join the Colonial administrative services in various parts of the Empire. The Empire Nursing Association have their headquarters with us. Their beneficent and most valuable work, which sprang from the practical enthusiasm, a generation ago, of a lady who, from personal experience, knew the crying need for trained nurses in at least one of our distant tropical islands, has now grown into a widespread organization.

The Board of Governors, last month, acceded to a request from the Commissioners of the Exhibition of 1851 and have placed at their disposal a small gallery in which will be exhibited annually the work of their School of Rome Art Scholars, as well as—from time to time—the work of young artists from all parts of the Empire, many of whom are at present entirely unknown outside their own Dominion or Colony, principally through the difficulty, pecuniary and otherwise, of bringing their work to the notice of art patrons in the Mother country.

These School of Rome scholarships—in painting, sculpture, architecture and engraving—were started some 15 years ago and from their inception have been thrown open to art students from every corner of the Empire, but up to date there has been no permanent gallery in which the selecting committee has been able to judge the work of the annual competitors or in which the work of the scholars, during their 3 years' study on the Continent, could be exhibited in England.

I cannot help feeling that the furtherance of the culture of the British Empire as a whole may in this and other directions be nurtured by the Imperial Institute without in any way detracting from its primary use as an important link between the raw products to be found all over the Empire and the industrialists in England and in great industrial cities in some of the Dominions.

In any case, I would ask you to realize that the staff at the Imperial Institute are only too anxious to give all the assistance they possibly can to the fullest development of the great resources of this Empire of ours, and I would suggest that, however greatly any single Dominion may accelerate the pace of her own self-development as a nation, the *imperial* aspect of that development is enormously important, both to herself and to the mother country, and to each and every other constituent part of the Empire. Each part can be and should be chiefly, if not wholly, dependent on the others. In that way, and in that way only, can we in this generation take our share in the consolidation and fruitful development of the marvellous heritage entrusted to us by the enterprise and self-sacrifice of our forefathers.

DISCUSSION.

THE CHAIRMAN, in initiating the discussion, said the lecturer had painted an attractive picture about an attractive subject. He (the speaker) had for a period of several years been a member of the Raw Materials Committee of the Imperial Institute, and had found no work more fascinating or more wonderful than looking into the raw materials of the British Empire. The lecturer had done a valuable public service in bringing together the facts connected with the Imperial Institute and enabling the public to know more than they already knew, which, unfortunately, was very little, about that great institution. He had fully grasped the essential importance of linking up our trade commissioners throughout the Empire with the Imperial Institute. It followed on that as our trade commissioners abroad were assisting the sale of British products and manufactures in the Dominions, they should also do all they could to help the Governments of those Dominions in securing an opening for their raw materials in the British Empire. He hoped the Governments of the Dominions would make every use they could of our trade commissioners; the Department of Overseas Trade desired to assist, and would be able to do so if those Governments intimated what raw materials they had which were not finding an adequate market. During the short space of time it had been in existence, that Department had made an efficient collection of information which they could place at the disposal of British manufacturers and others. That was information which the Imperial Institute did not possess and which it would take it a great deal of time to acquire. In the British Empire we possessed a world flowing with milk and honey; all we had to do was to make use of it. The deplorably high percentage of silk imported to this country from foreign sources to-day was to be compared with the position as to rubber 20 or 30 years ago, when we were dependent for our supplies for the most part upon Brazil. An enterprising soldier and scientist had then taken seven rubber plants to Kew Gardens, which was an institution much of the same character as the Imperial Institute. After a few years of experiment results were obtained which eventually led to the establishment of the very valuable rubber industry in the British Empire, in Ceylon and Malaya. If that could be done with rubber, there was no reason why the same should not be done with silk, and, indeed, the Imperial Institute was about to make investigations and experiments with regard to increased production of British silk. The artificial silk industry would not compete with the production of real silk. There was a great future for silk in Irak, Kenya, and perhaps some of the West Indian Colonies. If the Imperial Institute could induce merchant venturers to invest their money in an attempt to create a successful natural silk industry in various parts of the Empire, it would by that alone have justified its existence.

Col. The HON. SIR JAMES ALLEN, G.C.M.G., K.C.B., High Commissioner for New Zealand, said it was a great pleasure to him to express his faith in the future of the Imperial Institute, although its existence in the past had not been an altogether happy one. It was not, or ought not to be, an Institute of Great Britain alone; it was an Institute of the Empire in which every Dominion and every Colony ought to be concerned. In the past there had not been the interest in the Institute on the part of some of the Dominions that there ought to have been, but he was very hopeful that under the system of re-organisation which the lecturer had explained, every Colony, India, and every Dominion, would take their fair share of interest in an institution which had been of great value in the past, and might be of still greater value in the future. In the first place, the Institute did the work of a clearing house of knowledge. Many a time when he had been asked questions

about raw materials, he had sent those enquiries on to the Institute, and in nearly every instance had received a satisfactory reply; and where the Institute could not itself furnish the solution, it could tell one where the information could be obtained. Those present who came from the Dominions would be delighted to hear from the lecturer that more opportunities were to be given to those in the mother country to learn about the resources of the Empire. The galleries of the Institute in the past had been of very great value in the education of children. We had not yet learned the great possibilities of our Empire.

With regard to research work, he reminded them that the Empire Economic Conference had expressed its anxiety that overlapping should be avoided. He felt sure that the Imperial Institute would recognise that Great Britain was not the only part of the world which was carrying on research investigation, but would make it its business to be the connecting link, making that knowledge available to anybody who enquired about any piece of work that was being done by the various research institutions, whether it was here, in India, or in New Zealand. In that way, by keeping in close touch with one another, each separate unit would get the advantage of the knowledge of the whole.

Col. Sir Charles Yate, Bt., C.S.I., C.M.G., said the lecturer had given them a really unique introduction to the work that was being done at the Imperial Institute, and had shown what an extremely valuable institution it was, not only for this country but for the Empire as a whole. As an Indian Officer, he personally took the greatest interest in the share that India had in this work. At its inception the Princes and people of India subscribed no less than £114,000 towards the building of the Institute. In addition, the Maharajah of Bhaunagar had contributed at a later date, for the Indian pavilion at the Exhibition Galleries, no less a sum than £17,000, and there had been subsequent subscriptions of £13,000 by Sir Cowasjee Jehangir and £3,000 by Sir M. Bhownagaree. That was an indication of the great interest India took in the Imperial Institute. A few years ago, when the funds of the Institute had fallen to a low level and the Imperial Institute Act was finally passed as described by the Lecturer, he could remember how glad India was to hear that the Indian Exhibition Galleries were to remain open. He himself had asked questions in Parliament on the subject, and had received an assurance from the then Colonial Secretary that those galleries would be preserved. Just before the Lecture, he had happened to pick up a copy of the "Quarterly Bulletin," referred to by the Lecturer, in the reading room below, and he was ashamed to say that that was the first time he had ever seen that publication, and he wondered how many there were present of whom the same thing could be said. He realised, however, what a valuable contribution to science and to the knowledge of our Empire that publication was, and he advised them all to read it.

He had attempted, when Chief Commissioner of Baluchistan, to start a silk industry in that country and had succeeded pretty well at the time, but the industry, he regretted to say, had since been discontinued. He could only hope that it might be revived. He very much appreciated the splendid work which had been done by the Cotton-growing Committee, and he hoped there would now be a Silk-growing Committee, which would be able to encourage the production of silk, not only in Baluchistan, Irak and Kenya, but throughout the whole Empire wherever it was possible to do so. He had been very much disappointed to find that the Advisory Committee of the Institute on Timber had made no mention of Indian timber, which had proved its good qualities in the Wembley Exhibition, where there were shown samples of the most magnificent timber. He sincerely hoped

that the Lecturer would do his best to make known the good qualities of Indian timber. He entirely sympathised with Sir William Furse's desire to make the galleries of the Institute into a permanent Wembley.

LORD ASKWITH, K.C.B., K.C., D.C.L., Member of Council, emphasised the importance of the present position of the Imperial Institute being brought to the attention of the country in the way in which the Lecturer had done, because ignorance of its work was a very serious matter. It was now nearly 40 years since the idea of that Institution was developed by King Edward VII., on the occasion of that wonderful wave of enthusiasm which characterised the first Jubilee of Queen Victoria. He (the speaker) remembered that time well when people from different parts of the Empire, perhaps for the first time, really awoke to the greatness of the Empire, and appreciated that they were part of it. The Wembley Exhibition had led to another move forward in that direction, and it was essential that the idea of Wembley should be carried forward for another generation. The Imperial Institute had had many vicissitudes; at least three Acts of Parliament had been required to get it into its present position; large donations, particularly from India, had been given to develop the idea, and it had progressed under different administrations. The first administration was under the chairmanship of the late Lord Herschell, a very able man, who had worked very hard, assisted as he was by the still harder work of that devoted public servant, Sir Frederick Abel. After him had come Lord James of Hereford, and Mr. Dunstan, as a Director of the Institute. The scientific side had now been separated from the administrative side, and he entirely agreed with that; it was impossible for a scientific man to devote himself to science and at the same time carry on the difficult work which was connected with the organisation of the Imperial Institute. The work of the Institute, besides research, had at least three important sides, the production or material, the industrial, and the method of appeal to the general public. We must know what the raw products of the Empire were and what the manufactures were which required those raw products before we could really make any use of them, or bring about due improvements in trade. The system of committees was no doubt very efficacious for the purpose of getting the best experts together on different branches of commerce. That system obviated overlapping, the curse of Government departments; it prevented different people doing the same thing at the same time, and so wasting their energies. By that method it would be possible to make known where improvements could be made, where the goods could be got, and, where there was ignorance of the kind of commodities that were required, they could resort to research, with regard to which the Institute could either do the work itself or direct enquirers to the proper bodies. With regard to public interest, the Lecturer had opened up a vista of what might possibly be done in the future. It was to be hoped that the idea of large use of the cinema would be adopted. In the past, visitors to the Galleries of the Institute had seen long rows of bottles, sections of trees, and things of that kind which the listless public looked at, and never came again. To-day window-dressing had become much more of an art, as was known by anybody who had to do with exhibitions, or, indeed, walked along the streets. The Lecturer was possibly a better window-dresser than anybody who had hitherto had charge of the Museum, and so might be able to interest the public so that they would come again and again. At least, the Lecturer had given one show which had interested London, when, as Master-General of the Ordnance, he had conceived and carried out the idea of the great exhibition of German guns in the Mall after the close of the war.

MR. ROBERT à-ABABRELTON said he was delighted with the lecture. He himself had devoted 50 years endeavouring to establish closer union within the British

Empire. When the Imperial Institute was initiated, it was thought that the activities of the Royal Colonial Institute, of which he, the speaker, was a Fellow, would be utilised; but that had not been done, and there were to-day those two Institutes with similar objects. He was very pleased to hear that the Imperial Institute was going ahead and doing the very work which the Royal Colonial Institute ought to have done, but was not able to do through lack of funds or ability such as was possessed by a Government Department. There was one matter to which he desired to call the attention, not only of the Lecturer, but of the Chairman, who occupied such an important position in the Government at the present time. As they all knew, not only did the British Empire comprise a number of different countries, but it also comprised a number of different peoples. In order to satisfy such peoples who belonged to the British Empire, whatever their colour, it was desirable to adopt some means of codifying their ancient usages. That had already been done in Natal where it had been one of the pleasures of his life to be able to do something in connection with the administration of Native law; but, so far as he knew, Natal was the only portion of South Africa which had adopted the principle of utilising the Native laws as far as possible for the Natives. The usual idea, when we went for instance to India, was, practically, to put in force British laws with regard to everybody. That seemed to him to be a mistake. Steps should be taken to consolidate the customary laws which had been used from time immemorial by these different peoples. It would be necessary, of course, to eliminate those practices which British ideas could not tolerate; for instance, in Natal, the Natives, if permitted, would murder each other for certain offences. If their usages and customs were codified in accordance with our British ideas in such a way as not to outrage the ideas of the people whose government we were administering, a great step would have been made towards the general appreciation of British government by these peoples, and we should probably secure their affection in much the same way as we had won the affection and loyalty of the Natives in Natal.

Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I., Member of Council, expressed his disagreement with the suggestion of the last speaker, that we had attempted to impose English law to a large extent on India, and had ignored Indian customs. He ventured to think there was some misapprehension on that point. From the earliest times of British rule in India the personal law of the Hindu had been the law for Hindus, while the personal law of the Muhammadan had been the law for Muhammadans. That was the state of things to-day; the affairs of these races were decided in accordance with the tenets of Hindu and Muhammadan law, both in the Courts in India and on appeal by the Privy Council. We certainly did not apply Muhammadan criminal law as practised in Turkey and Persia to the Muhammadans of India, and he did not suppose the people of India would desire it. The administration of native law was, perhaps, most conspicuous in the Punjab, where an enormous amount of work had been done in codifying the customary laws. The whole of the settlements of the Punjab were really based on customary law, and he did not think anything could have been done of a more valuable nature. He intervened in the discussion merely to prevent any misapprehension arising on this subject.

Mr. Robert à-Ababrelton said that he appreciated the truth of what the last speaker had said, but it was, nevertheless, the fact that in many parts of the Empire the customary laws had not been coded, with the result that those who acted as Judges were sometimes misled by interested partisans.

The Meeting concluded with a vote of thanks to the Lecturer.

NOTES ON BOOKS.

An Account of the Scapa Society. By Richardson Evans. London: Constable and Co., Ltd. 6*s.* net.

The aims of the Society for Checking the Abuses of Public Advertising (more familiarly and more conveniently known as the Scapa Society) must appeal to all who respect the beautiful and detest the ugly, and they should appeal especially to Fellows of the Royal Society of Arts, for it was in this house that the earlier meetings were held. Its objects are :—

(1) To protect the picturesque simplicity of rural and river scenery and to promote a due regard for dignity and propriety of aspects in towns; with special reference in each case to the abuses of spectacular advertising.

(2) To assert generally the importance, as a great public interest, of maintaining the elements of interest and beauty in out-of-door life.

Mr. Richardson Evans was for many years the Honorary Secretary of the Scapa Society, and in this volume he gives an interesting account of its history and achievements. It was founded in 1893 under the presidency of the late Alfred Waterhouse, R.A., and rapidly attracted a large and influential membership. Its energies were directed to securing legislation on the subject of disfiguring advertisements, but it was not until 1907 that the Society achieved the passage of a statute. This act did not go very far, but its importance lay in the fact that "it asserted the principle of control (of advertisements) for the first time in the history of English Jurisprudence." Attempts were subsequently made to strengthen this act, and fortunately a further law was passed in 1925, whereby local authorities are empowered to make by-laws for the regulation and control of hoardings used for the purposes of advertising when they exceed twelve feet in height, and "for regulating, restricting or preventing the exhibition of advertisements in such places and in such manner or by such means as to affect injuriously the amenities or a public park or pleasure promenade or to disfigure the natural beauty of a landscape."

The Scapa Society has already achieved a fine record of work, but unfortunately much remains for it to do. Any one who passes through the Scotsman's cinema, as the nightly horror of Piccadilly Circus has been called, will hope that the Scapa Society will soon be empowered to deal with this problem. It is already tackling the distressing habit of scattering paper and other forms of litter in public places, and we fear it will be long before the need for its beneficent activities passes away.

The British public owes much to Mr. Richardson Evans for the unselfish work which he has put into the cause, and the debt is by no means lessened by the admirable account which he has given of the Scapa Society.

The Secret of High Wages. By Bertram Austin, M.B.E., M.A., and W. Francis Lloyd, M.A., A.M.I.E.E. London: T. Fisher Unwin, Ltd. 3*s.* 6*d.* net.

It is common knowledge that in recent years America has witnessed extraordinary advances in the standards of living and the rates of wages. In order to study the circumstances which have made these advances possible, the writers of this volume visited the most important cities of Eastern America, inspected a large number of manufacturing plants and other commercial organisations, and discussed industrial policies and methods of manufacturing with many leaders in American life. The results of their investigations are embodied in this report, and they are such as to deserve the most thoughtful consideration of every one who has at heart the interests of British industry.

There can be little doubt that the amazing prosperity which America is now enjoying is mainly due to the example of Mr. Henry Ford. He led the way by instituting a bold and novel managerial policy, and other employers were quick to follow his lead. The first important line of his policy is that it is more advantageous to increase profits by reducing prices to the consumer, at the same time maintaining or improving quality, with a consequent increase in the value of sales, than by attempting to maintain or increase prices in this connection. Some figures quoted with regard to the output of the Ford Motor Company are illuminating. In 1908 the production of motor cars was 10,660 at a price of $950. In 1924 the production of the same models was 1,993,419 at a price of $290. In other words, while the price in 1924 was one-third of the 1924 price, the output was increased 200 times. While the profit on each car is very small, the enormous rise in the number of sales results in very large aggregate profits.

The second point of importance is that there is no limit to a worker's output nor to his wages. Instead of the standard of each worker's output being reduced to that of the most incompetent, every inducement is given to every man to increase his output to the utmost. Those who advocate the policy of "Ca'canny," and those unfortunate workmen who are victimised by it, would do well to study the effects of the American system, and the benefits it confers on those who take advantage of it.

Many other points are dealt with by the authors, such as the elimination of waste, attention to welfare, the importance of research, etc. On all these points we have much to learn from America, and our thanks are due to Mr. Austin and Mr. Lloyd for the concise and admirable account of American manufacturing methods which they have placed before us.

HANDCRAFT IN WOOD AND METAL. By John Hooper, M.B.E., and Alfred J. Shirley. London: B. T. Batsford, Ltd. 10*s*. 6*d*. net.

The authors of this work on craft work in wood and metal, of which a second edition has recently been published, have both occupied positions under the London County Council as lecturers and instructors in craft work, and have, therefore, personal experience of the practical and educational requirements of a manual of this description, which, while primarily designed to assist teachers, is also intended for the craftsman and pupil. Approximately half of the book is devoted to a series of chapters, with illustrations and directions, dealing with models for work in wood and metal for first, second and third year pupils, while questions such as the application of historic craftwork to classwork, design, decorative processes, tools, buildings and equipment, are dealt with in the remaining chapters. The book should be of especial interest to teachers and others responsible for the direction of craft education in technical schools.

JOURNAL OF PHILOSOPHICAL STUDIES: published quarterly for the British Institute of Philosophical Studies by Macmillan & Co., Ltd., London.

The objects of this new quarterly journal of the British Institute of Philosophical Studies, which was recently formed for the purpose of promoting the advancement of philosophical studies by teaching, discussion, and research, are given in an editorial preface to the first number published on January 1st of this year. It was believed by the group of persons who initiated the movement to found the Institute, that there exists a large number of thoughtful people in the professions and in the worlds of literature, art, industry, and commerce, as well as among men of science, who,

weary of trying to find a solution for the problems of modern civilisation which, like a kaleidoscope, as soon as one problem seems to have been solved, immediately presents you with another or the same problem in a different form, are seeking to reach a deeper level of reality than is to be found in the arguments and counter-arguments of parties and classes, and are turning to philosophy for light and guidance. This belief has been confirmed by the growing membership of the Institute which now numbers many hundreds.

It will be the policy of the Journal to avoid being too severely technical and to include articles which can be appreciated by every well-informed and educated person, as well as accounts of the discussions held by the Institute in London, and reviews of philosophical literature in various languages.

The names, printed on the cover, of the eminent philosophers who will collaborate with the editor in the production of the Journal, as well as the excellence of the articles and other matter in the first number, inspire a high degree of confidence in the success of this new venture.

WESTMINSTER ABBEY RE-EXAMINED. By W. R. Lethaby. London: Duckworth. 21*s*. net.

The present volume is a supplement to the same author's "Westminster Abbey and the King's Craftsmen," published in 1906 and now out of print. The subject of this, as of the earlier work, is the form and architectural details of the Abbey Church and the craftsmen who were responsible for these. There are fifteen chapters, each of which is devoted to an account of some particular portion of the structure or of some special aspect of the whole, such as sculpture, illumination, stained glass, wood, metal and tile work, and so forth. The book is the result of a close study of the Abbey carried out in upwards of a thousand visits and contains a large number of most excellent illustrations of architectural details, reproduced from the author's own drawings. It should prove of great value and interest to students of mediæval architecture and craftsmanship.

THE LAW AND PRACTICE OF HALL-MARKING GOLD AND SILVER WARES. By J. Paul de Castro. London: Crosby Lockwood and Son. 42*s*. net.

This volume, which has been prepared by Mr. de Castro, of Lincoln's Inn, mainly for the use of goldsmiths and silversmiths in their relations with the hall-marking authorities and for the assistance of dealers in gold and silver plate, aims at supplying as complete and concise a survey of the existing law on hall-marking as the rather intricate nature of the subject allows. Inasmuch as the explanation of existing marks and practices frequently involves references to the historical development of hall-marking, the book will also have a considerable interest for the collector.

Part I., or nearly half the volume, is taken up by an introductory chapter and chapters on marks, exemptions from marking, the State-recognised assay offices, the advantages of the hall-marking system, licences to deal in plate, etc. Part II. gives the case-law, and in Part III. is a collection of the Statutes, revised and annotated, and statutory rules relating to the subject. The book also contains thirty-four plates illustrating marks.

YERBA MATÉ INDUSTRY OF PARAGUAY.

According to the annual Report on conditions in Paraguay by H.M Chargé d'Affaires at Asuncion, the yerba maté or Paraguay tea industry, consisting in the gathering, torrefaction and grinding in a peculiar manner of the leaves of the yerba tree (*ilex Paraguayensis*), is carried on under conditions which still retain much of the elements of romance and adventure which have been associated with it for generations, but which modern methods must, of course, sooner or later displace.

The tree grows wild throughout the eastern half of Paraguay in the forests that cover some 25,000 to 30,000 square miles. These forests are privately owned by individuals or companies, of the latter of which the most important, owning a property nearly 10,000 square miles in extent, is British-controlled. Owing to the vastness of the forests, the difficulty of access thereto and the value of the product, the cutting and elaboration of yerba by unauthorized persons is a common practice, and one difficult to restrain. The matter is one which, sooner or later, must seriously engage the attention of the Government.

The planting and cultivation of yerba as an industry is steadily increasing, and although most of the plantations in Paraguay are still too young to enable the supply to swell noticeably the yearly production, it is certain that in a few years the quantity of leaf available for export will be greatly augmented, as will be the revenue derived by the Government from the imposts and taxes to which the product is subject.

The quantity of yerba exported in the years 1922-24 were 5190, 5118, and 6908 metric tons respectively. During the first six months of 1925, 5,703 tons were exported.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MAY 24..University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. Henry Wickham Steed, "Central Europe and the Peace." (Lecture III.)
5.30 p.m. Dr. Hubert Hall, "Some Aspects of Diplomatic Study." (Lecture III.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. J. B. Collingwood, "The Influence of Water on Vital Processes." (Lecture VII.)

TUESDAY, MAY 25..University of London, at King's College, Strand, W.C. 4.30 p.m. Dr. J. W. Pickering, "The Constituents and Coagulation of Blood Plasma." (Lecture I.)

WEDNESDAY, MAY 26..University of London..At the London School of Economics, Aldwych, W.C. 5.30 p.m. Prof. P. J. Noel Baker, "Practical Problems of Disarmamant. Lecture V.: General Conclusions."

THURSDAY, MAY 27..Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Mr. U. R. Evans, "Corrosion of Metals." (Lecture II.)

Linnean Society, Burlington House, W. 5 p.m. Anniversary Meeting.

Mining and Metallurgy, Institution of, Burlington House, W. 5.30 p.m. General Meeting.

University of London, at University College, Gower Street, W.C. 2.30 p.m. Prof. Sir Flinders Petrie, "Recent Discoveries in Egypt."
At University College, Gower Street, W.C. 5.30 p.m. Prof. Niels Bjerrum, "The new Aspect of Strong Electrolytes" (in English). (Lecture I.)
5.30 p.m. Commendatore Luigi Villari, "The Economic Problems of Italy."

FRIDAY, MAY 28..Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m.
Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir Almroth Wright, "Aims and Methods of Therapeutic Research."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. J. A. K. Thomson, "The Development of Irony." (Lecture II.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. Niels Bjerrum, "The New Aspect of Strong Electrolytes" (in English). (Lecture II.)
At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. E. Beddington Behrens, "International Problems of Industry." (Lecture V.)

SATURDAY, MAY 29..Royal Institution, 21, Albemarle Street, W. 3 p.m. Prof. A. Moret, "Une Révolution sociale en Egypte vers 2,000 Av. J.-C."

University of London, at University College, Gower Street, W.C. 3 p.m. Prof. Sir Flinders Petrie, "Recent Discoveries in Egypt."

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FRIDAY, MAY 28th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, MAY 31ST, at 4.30 p.m. (Indian Section.) LIEUT.-COLONEL SIR ARNOLD TALBOT WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., "The Military Record and Potentialities of the Persian Empire." BRIG.-GENERAL SIR PERCY M. SYKES, K.C.I.E., C.B., C.M.G., will preside.

A cinematograph film illustrating the daily life of one of the warlike races of Persia will be shown (by kind permission of Famous Players' Film Company, Ltd.).

Tea will be served in the Library from 4 p.m.

PROCEEDINGS OF THE SOCIETY.

SIXTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 21ST, 1926.

THE RIGHT HON. VISCOUNT CHELMSFORD, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., in the Chair.

THE CHAIRMAN said it was a very great pleasure to him to be able to preside that evening at the lecture which was going to be given by his old friend Sir George

MacMunn on "Some Aspects of the Business Side of an Army." Few men were better equipped to lecture on that subject, whether upon the business side of an army in war or the business side of an army in peace, than Sir George MacMunn. In 1916 Sir George had taken up the responsible position of General Officer in Command of the Line of Communications, and he had had the great good fortune to be able to supply General Maude's Army all through those days when the British were fighting to turn out the Turks from Kut; and then, when the flank of the Turks had been turned in Kut, Sir George MacMunn went up there to see General Maude. General Maude was very anxious to pursue the Turks at once. That was on February 27, and Sir George MacMunn pointed out to him that it was all very well, but he had never been told that the next destination of the British Army was Bagdad, and he must have a few days in which to supply the Army in its advance on Bagdad. General Maude asked him how long he wanted. He said, "Well, if you will give me till the 5th March I shall be able to do what you want;" and so that modest request of five days was given to General MacMunn, and as everyone knew, the Army advanced from Kut on to Bagdad, another 260 miles or so, making some 500 odd miles by water, which was, of course, the main line of communication; and that Army never failed or wanted for supplies. Then Bagdad was taken, and it fell again to General MacMunn to see that all the various bodies that went out east, north and west from the force at Bagdad should equally be supplied, and history recorded how that great force under General Maude never wanted for anything that it required in the matter of supplies. Then, after having occupied the position of General Officer Commanding in Mesopotamia, General MacMunn had gone to India as Quartermaster-General. Of course, there had been considerable changes on the "Q" side with regard to the Army shortly before General MacMunn came. The old "silladar" system with regard to the Indian cavalry had been abolished. It had broken down in war, and it was necessary that Army Headquarters should take the responsibility for equipping and supplying the Indian cavalry. Similarly it had been found that the Indian soldier who had never received rations, but had always received an allowance which he was supposed to be spending on rations, as a matter of fact was starving himself and saving for his family out of that allowance, and that from the point of view of the Army, if one wanted an efficient Army, one must see that the men were fed well. So the Government of India at that time determined, despite the criticisms of some and the apprehensions of others, to take upon themselves the rationing of the Indian Army.

General MacMunn had to deal with all that business, because it was not absolutely completed when he took on his duties as Quartermaster-General, and he had the additional difficulty that while in time of war one can always get money for things, he had come upon times when finance was stringent and people were not quite as ready to supply him with money for his wants as they were in time of war. But at all events his four years as Quartermaster-General in India had been a most distinguished four years, and had established on a sound footing the supply side of the Indian Army.

From that very brief description of Sir George MacMunn's experience, both in war and in peace, it would be realised that he was fully qualified, and as well equipped as any other man, to say something before the Royal Society of Arts on the business side of the Army.

The following paper was then read:—

SOME ASPECTS OF THE BUSINESS SIDE OF AN ARMY.

By Lieut.-General Sir George MacMunn, K.C.B., K.C.S.I., D.S.O.

The Housekeeping of an Army.

When this Society paid me the compliment of inviting me to lecture, they approved of the subject of my discourse to-night as one likely to interest you, so should you find that it is intensely dull, I trust that you will vent your displeasure on the Council rather than on the lecturer. But dull perhaps as the subject may be, it has human aspects and inner aspects that are not devoid of romance. You will remember those verses of Rudyard Kipling, "Farewell, romance," which bring out the theory that there is romance enough in all and every subject in the world, and in every age. A visit to the thrills of Brooklands, for instance, leave the stage coach standing in the matter of adventure.

I propose if I can to interest you in a very large side of the business of an army, both in peace and war, which is so often not thought of because it is not so immediately apparent, but without which no army can exist for a moment. I mean the army housekeeping. An army still crawls on its belly, even if motor transport and railways enable it to crawl a little less slowly. The mass of men in an Army, which, as in the Great War, grew to millions, and in ordinary times in this Empire, including India, may, perhaps, total half a million, apart from its fighting work, has the same immediate personal wants as you or I. It has to be fed, clothed, housed, equipped, moved, provided with horses, wagons and motor transport. Its demands are immediate and insistent in peace and in war.

Now, no doubt, many of you are conversant with the Trinity who manage the affairs of an Army either under a Commander-in-Chief or under a corporate body, such as the Army Council, viz., the Chief of the General Staff, who manages the policy and purpose of an Army, its armament, its training and its use, and who is the official remembrancer to the Cabinet on such matters. Then you have the Adjutant-General, the Lord of the cannon fodder, the producer of the man-power and all that appertains to his conduct and well-being.

The third of the Trinity is the Quartermaster-General, who, as his name implies, is responsible for everything required in quarters in peace and war. He is the giant housekeeper and his troubles and anxieties are in many ways those of every housekeeper in England, but his are those of the master as well as of the mistress of the house. I propose to deal with some of the responsibilities of this master housekeeper, especially when he touches—and he touches a good deal—the commercial and business principles of life as well as with its human aspects. It would not interest you if I dealt with the more military aspects of his duties, or of his repre-

sentative with the Commanding Officer of a unit who is usually referred to in the ranks as the Quarter-bloke.

There is a fourth member of the Army Council, not in intimate touch with the troops, who does not actually come into the field, viz., the Master-General of the Ordnance, or, as he is termed in India, the Master-General of Supply, who produces, *i.e.*, conducts, government factories, etc., and carries out construction.

THE QUARTERMASTER-GENERAL AS UNIVERSAL PROVIDER AND HOUSEKEEPER.

The actual subjects with which all Quartermaster-Generals have to deal are the Provision and Distribution of Food, the Provision and Storing of all Equipment and Arms, every sort of household utensil and requirement, the Provision of Horses and of Motor Transport, the Veterinary care of Animals, and all movements and problems of quartering, viz., the housing of the Army. In India he has in addition other duties necessitated by the general conditions of the country, where private trade and enterprise cannot always produce what is required, and—a very big question—the administration of the special semi-military townships in which the Army and the civilian satellites who minister to its needs reside.

THE BUSINESS ANALOGY.

In the organizing of the public services it is not always easy to get a clear division of duties so that friction can be avoided. Nor is it always possible to be logical, for other equally imperative factors may make for some compromise. There is a useful business analogy which I have found effective in explaining the principle that should govern this matter of military housekeeping. It was that on which Lord Rawlinson based his final re-organisation of the military machine in India which had been left unfinished for some years after the Great War.

This analogy does precisely define the relationship of the Quartermaster-General to the Army and to trade and manufacture and to the Master-General of the Ordnance or the Master-General of Supply so far as those officials control the factories of the Army. I commend it to those who study the question, for it is very easy to get the reins crossed when working out schemes of organization. Neither the fighting soldier, who deals with other matters, nor the statesman, who has to handle such problems in the end, are always very clear on the principles that must govern a well-organized machine behind the Army.

Speaking generally, the Quartermaster-General should have the same position towards the Army as businesses like the Army and Navy Stores or Selfridge's have towards the public they cater for. It is his business to gauge his customers' wants, to tell the manufacturers what he wants from them, to see that he gets it, and then to locate his supplies so that his

public may find what they want conveniently and draw it as required. It is not for him to manufacture, indeed it is not for the Army to do any manufacture at all when there is a trade eager and qualified to do it, unless there be special reasons which I will refer to later. The big stores do not, as a rule, manufacture what they sell, though now and again they also for special reasons set up their own factory for certain classes of products.

When a big distributing agency also manufactures, it is apt to disturb the course of trade. For instance, I think I am right in saying that one of the reasons why so-called pirate buses have appeared on the routes of other companies is because some of those companies have taken to building their own vehicles, and, therefore, forced manufacturing firms to become also using firms or perish.

The analogy I have used shows you clearly that the Quartermaster-General is a foreseeing, ordering and distributing agent, and in war time these functions become doubly marked.

The Purpose of an Army.

Now before all things it is necessary, both in peace and in war, that a Quartermaster-General shall know what is required of him. As a housekeeper must know who is coming to the house to dine or to stay, so must a Quartermaster-General have a policy given him. It is so obvious to you all that it seems absurd to mention it, but, until the great reformation of our Army principles which followed the South African War, and which only came to its fullness when the mentality of Lord Haldane was added to the zeal of the rising generation of Army leaders, we were very deficient in any policy at all. We now, perhaps, forget how in the days when Lord Wolseley was struggling to get an Army system, we were very deficient in even an Empire policy. Such as we had was a very vacillating one at best, and different parties in the State had very different views. There was then a much larger "perish the Empire" party than there is now. Our Governments could not make up their minds what our land policy should be, and, with the Cabinet giving no strong lead, the War Office was at sea. But with the progress of German aspirations to stimulate the growth of our own clear thinking, and with the inauguration of the General Staff to do the clear thinking of the Army and to stimulate the Government in theirs, a policy of Army organization appeared. Among the clear signs that providence was on the side of the British, I would venture to instance the coming of Lord Haldane, the formation of the Expeditionary and Territorial Forces, and the calling into being of a General Staff in time to get fairly ready for this terrible war. I do not think we could have been victorious and made our Allies so with such a citizen Army, for instance, as the United States evolved with such great difficulty in their Civil War.

However, that is all another story. The point that I am making is that

in peace time a policy is essential in every kind of work if the housekeeper is to keep a good house. For several years after the War our policies of necessity were obscure and the Quartermasters-General were much harassed accordingly. In war time a policy is equally essential, but the timely communication of that policy to the housekeeper is equally important. You cannot have a dinner for twelve if you only give warning half-an-hour before. I have referred to all that a General Staff have done for us. As a Quartermaster-General I also know some of the failings of that body, how they sometimes expect Heaven above to feed the Army with manna and by the agency of ravens, and that even without telling Providence what their prayer will be; and at times they fail to envisage the magnitude of the services they require: how at times they do not even warn the housekeeper of the dinner party they have arranged. Our Staff, however, are, no doubt, but small offenders in this respect, for it is obvious from the various German War Memoirs that other General Staffs have far greater and worse failings.

But the business fact that I want to rub in, is the necessity of taking the housekeeper into your confidence and listening to him when he tells you how many loaves and fishes and how many pots and pans, and how many cooks and how many blankets the house party you propose to give will require. Of course, I do recognise that there are occasions of strategy when the left hand must not know what the right hand is doing, and so long as the loss of efficiency concomitant with unavoidable secrecy is understood, well and good.

The Difference Between Peace and War—Peace Estimates.

The difference between peace and war administration is immense from the financial and economic point of view, and, indeed, they can hardly be compared. In peace time you work by your estimates, and except for small margins, there is nothing to deviate from. You have so many men to feed, and so many men to clothe. That number cannot be exceeded without Government orders, and should such orders be given there will be the necessary Treasury provision. The Quartermaster-General need not fear here; he has a fixed sum to handle based on the probable cost of what he will have to buy and the probable requirements of the Army. The financial provision for these requirements is based on years of previous experience. For some time after the War much of the old experience was out of date and this gave rise to much trouble and much discussion with the financial authorities as to what the requirements for the ensuing year would be. The Quartermaster-General's leading subordinates, the heads or directors, as they are called, of the various technical services, are anxious not to run short and may pitch their estimates too high. These have to be duly regulated. And the Quartermaster-General has to see that while

the Army is not let down, the "services" do not get on too soft velvet.

I will treat of estimate framing a little later, and once those are settled it is fairly plain sailing. The Q.M.G. has many million pounds to handle, but the dividends of his business are not to be estimated in cash. He is a corporation "not trading for profit," and his dividends take the form of promptness, efficiency and satisfaction of its members, much as is the case with the management of a large club. If the market prices vary considerably from the figures in the estimates and his cost of maintenance is increased beyond the funds at his disposal, the Treasury must come to the rescue if the money cannot be saved under some other heading of Army votes. There are certain articles of clothing and food that he must stock for sale to the troops. He takes credit for the probable returns under this head in his estimates, and he really has only to find the capital for his working stocks.

It is over this matter of stocks that the Q.M.G., the heads of departments under him, and the Treasury officials most often come to loggerheads. As I have said before, the heads of the departments always want to be on velvet. They are always anxious lest they should run out of stock and incur the contumely of their customers, the Army, and perhaps the anger of the Q.M.G. The financial officials always want to cut down stocks and are always anxious that the year's work shall be carried out with a smaller working balance than proposed. The Quartermaster-General is generally in both camps. Economy is his watchword, and he does not mind using the Financial authority or the Treasury criticism to beat his own dog within reason. But he is not going to have the Army suffer though he does not mind his own directors having a little agony of mind if he thinks they can really rub along. He does not mind also having a bit up his sleeve where outside relationships are concerned, but he rather objects to having the same game played on him by his own subordinates. At the same time, he has to protect his directors, especially if he can trust them not to want too much velvet beneath their feet or their seat.

Fortunately for the Q.M.G. in this country, the Treasury and Financial officials are possessed of some human understanding, and once they are convinced they do concur. In India the Finance Department officials have little general knowledge of affairs, and a lot of time is wasted in convincing them of what a little more *savoir faire* would render unnecessary. In India you waste a lot of time arguing whether or not troops do want food before you discuss the question of stocks, and it is what makes the Indian Government live in that sea of paper which all the big men gird at but are too busy to have time to kill. Now that there are more Indians in the administration who love argument for argument's sake, the difficulty of getting on with the job is worse.

It should be clearly understood, but often is not, that working stocks

and war reserves are not the same thing, except for the purpose of turnover, and have entirely different merits. Though in calculating your war reserve it is, perhaps, admissible to count a proportion of your working stocks therein.

The business of estimating for the ensuing year is, of course, a difficult one, provocative of argument, and resembles the estimates that a large firm must make, with the exception that in business the goods sold make their own money, while in the Army the goods issued do not. When estimates are being framed the Financial authorities very naturally want to make an accurate budget, as over-estimating is anathema.

The military financial authorities, however, know that the Army has been sucked dry and want a little surplus for some really urgent matter, over which the Secretary of State was not prepared to go into the last ditch with the First Lord of the Treasury, or fight out in the Cabinet, but which it may be possible to get later if there are any unexpected savings accruing.

The Treasury, however, has the nose of a blood hound and the eye of a hawk for hidden reserves. It always suspects departments of a clever bit of budgetting that will leave something over towards the end of the year and likes to be the sole body that may play that game on Parliament. I fancy wives are good at that kind of camouflage, and as a member of the husbands' league I rather sympathise with the Treasury, but in my role as Q.M.G., or super wife, I would not mind if my departments humbugged the finance officers a little. Fortunately for the departments, the finance officers don't know everything. I have often in days gone by, as a junior at the War Office, after emerging from a financial tussle with most, but not quite all, my tail feathers gone, said: "Thank God those devils don't know everything." So you see the Financial Officers and the Treasury are your very faithful servants. So, however, are the Army Officials, but they know that the Army or the Navy, as the case may be, has been so pinched to make a Parliamentary holiday that it can't do its duty by you and sometimes they want to pinch back.

But from what I have said, you will see that in reality the super housekeeper is not really pinched for money for carrying out his approved services, but there is not much left for, let us say, buying a new drawing room cushion out of the housekeeping grant. In the jargon of the Treasury such a proceeding would have to receive prior sanction and be covered by the provision of Vote 2 subhead b, paragraph ii, or whatever the appropriate heading would be.

I have told you how the little quarrels go on over working stocks, but here in England the departments are usually allowed enough. In India they have far lower working stocks, and are always in difficulties. I remember spending a very bad Christmas week under a bombardment of telegrams to say that the extra issue blankets had run short; it did not

help the Army if I had replied: "I knew they would, but the finance department said we should want less and higher military authority had not rallied to my side."

The economies of which you have heard so much this year have largely been made by cutting down working stocks and reserves. The former may land you in temporary trouble, the latter is far worse, but is permissible for a year or so if your horizon is set very fair. There is an interesting business point in connection with the using up of reserves and surpluses. We had, of course, enormous stocks after the war. If you use a surplus up each year instead of placing new orders you may kill your trade and in technical military stores not in use by the world, you may lose your skilled operatives for ever. You have to use up your surplus stocks very slowly. When Lord Inchcape's economy committee came to India, I was taken sharply to task on the apparent high paper value of my stocks. But I explained, for instance, that there was, among other items, a large surplus of rifles, that even if we placed no orders with the factories and let them discharge their skilled hands, I could not use them up for many years, but I could, of course, get rid of them if we took them to the frontier and opened rifle marts for sale to the tribesman in the border hills, with ammunition. But it was obvious that the inhabitants on our side of the border, the police and the Army would not like the proposal!

Surplus stocks of any article, even of gold, is a curse. Had we known more, it would have paid us to burn our surplus boots and sink the German cargo vessels rather than pay the dole to craftsmen, while their usual customers lived on surplus stocks.

I spoke just now of the diversity of opinion among soldiers in the bad days when there was no one to lead opinion and policy. In those days the War Office Finance Branch knew very well that sometimes new proposals hotly pressed by some enthusiasts were not likely to be accepted for long, and that money spent on them might not be well spent. But as the military side of the War Office had agreed for the moment, it would not be seemly to protest too much. There was, however, another method of defeating the soldiery. It was said that there were two forms of drafting the necessary letter to the Treasury advocating the measure. One form quite unexceptionable in its wording meant: "You may safely oppose this. Military minds are not strongly united." The other less seldom used meant: "You may fight this for form's sake, if you like, but you must only use blank for you will have to give way in the end."

The letter which conveyed the information of irresistibility ended, it was said, with the following formula: "And, therefore, Mr. Secretary Stanhope confidently expects that My Lords will recognise the urgency and the propriety of the proposals now put before them."

These are stories of the bad old days, but you will see how this matter

of preparing the budget is no easy one, and that you have something more to deal with than the Chairman of a Board of Directors who is prompt to recognise good business and to make his business a success, and yet you will know cases where in the business world energetic and enthusiastic departmental managers have difficulty in persuading the Board of the practicability and the financial soundness of their proposals.

WARTIME.

When we come to war time it is a very different matter. For any sort of campaign forethought is necessary and full conception of what the earlier stages are likely to require, the number of troops to be fed and the sort of material that will be needed. But the pecuniary conditions are quite different. There is a vote of credit, for which the administrative and financial authorities put their heads together. The important matter is to go large, to know what you want, to get it at once. You will want large stocks on hand. There is not much danger of overstocking, as there will be time as the war draws on to a close to let the stocks die down. Of course, I am not talking of such a cataclysm as the Great War, which collapsed suddenly after waging at full pitch. In such cases you are bound to have enormous stocks, and you must never understock in war. Success is everything and it is in success that you calculate the dividends on the money expended.

Victory, the saving of life, preservation of health are the dividends that the shareholder, or, rather the taxpayer, gets. All the more when the taxpayer is himself in the ranks is he prepared to shoulder any burden rather than suffer the evils of an ill-found Army. Money must not, of course, be squandered. Wisdom and a sense of proportion is naturally necessary in all things, but ammunition in a fight is not to be gauged in terms of money. Availability is the first consideration. In the earlier stages of the Great War many of your responsible authorities had not a wide enough horizon. I could tell you stories of Gallipoli and Mesopotamia that would make angels weep. Sometimes military authorities on the spot would not ask for what they wanted. Sometimes they had not the knowledge to tell them. Sometimes home authorities would not send what was wanted. Sometimes Governments did not know how to get what was asked for. Sometimes the realities of War did not trickle into important mentalities for years.

Let me explain from an experience of my own the point of availability. I was responsible among other things at one period of the war for developing the Port of Basra with the expert advice and assistance of that able engineer, Sir George Buchanan. We went very large in view of the instructions that I received personally from the Q.M.G. in England, as well as from my own Commander-in-Chief. And many wharves were constructed and modern appliances, electrical derricks, etc., erected, with labour-saving devices and

the like. When challenged on the cost, I was able to say, and my point was immediately recognised, that in the critical years of the war the cost of 24 hours' delay in port to ocean steamers which were being sunk in such large numbers, could not be gauged in money figures. No expenditure, apart from mere waste, was too great to improve the turn round of ships. When Buchanan's plans were finished and the port directorate was in working order, we turned round our vessels in three days whereas before they had been detained in open stream with Arab lighters from twenty to thirty days.

I only mention this as a very effective reason for heavy outlay and the importance of the factor of availability.

I do not propose to touch on the great question of a Ministry of Munitions. We have plenty of experience now, that as soon as a war threatens to be of any size, we have to weld all the productive and business resources and brains into the service of war. In India the formation of the department of the Surveyor-General of Supply has aimed at creating a branch which could at any moment blossom into a Ministry of Munitions. In England the long-established Department of the Master-General of the Ordnance is not quite so adaptable, but the main principle is the same.

When an Army Must have its own Sources of Production.

I have said that normally an Army should get its requirements, especially in those commodities which are also used in civil life, from the trade. It then has the trade accustomed to its requirements, and only too willing to expand whenever a demand for increased supply arises.

The above is an axiom, but there are two main exceptions thereto. The first is that in essential requirements, which are not in use in civil life, such as armaments and ammunition, you cannot rely entirely on civil firms. They might fail you, while blankets and boots, for instance, being a civil requirement, must always be obtainable. It is also a fact that in certain requirements Army factories are necessary to set a type and to study new improvements. For this reason also the Army makes some of its own guns and some of its small arms and some of its ammunition. You cannot study improvements and inventions in a laboratory or a drawing office alone, and it is necessary to have a factory to your hand. A subsidiary point is that in the making of guns and rifles flaws can only be detected during manufacture and to do this you must watch manufacture. This can only be done by very efficient inspectors and it is often desirable to train these in your own factories. This is another subsidiary reason for an Army having factories of its own.

The Army also applies this exception to its clothing, for adequate reasons. It could get all its clothing made up by contract, and, of course, the real factory is in the cloth weaving, not in the making up. But the Q.M.G. finds it convenient, both in Great Britain and in India, to make

up a considerable portion of the clothing in Army factories. This has the advantage of permitting sudden expansions and contraction of work to meet special demands or reductions, without interfering with outside contracts. The actual making up, of course, is by piece work, the set of components being issued to the worker. Inspection of clothing is an important matter, and in the clothing factories there are three different inspections, that of the textiles when delivered from the makers, that of the clothing when made up by the workers in the factory, and that of the clothing sent in by outside firms. Perhaps one of the most important functions in a clothing factory is the making up of new patterns. That portion of the trade which takes up Army contracts is very susceptible to rumour as to changes, and the making up of trial patterns is far better kept quiet. Trials are, therefore, made in the Army factories. Sufficient contract work is usually given out to keep the trade interested in Army clothing and, therefore, ready for expansion.

So far what I have said only expands the first justification for the Army making certain things for itself. The second reason to which I have referred is when the trade cannot give you what you want. In India, for instance, the Q.M.G. was compelled to grow all the Army fodder or, at any rate, to cut it, and similarly in most places no business existed that would supply decent dairy produce, and he has had to run large dairy farms. I will refer to these later.

THE DIFFERENCE BETWEEN HOME AND INDIA.

There are many points of difference owing to the peculiar conditions of that country between the housekeeping in India and as carried out in Great Britain, and the history of some of them is remarkable. Speaking broadly, till the Great War, Government neither fed, housed, clothed, nor even mounted the large native Army of India. The food was covered by the pay at an average price for a fixed scale. When prices exceeded the average, a monthly scale of compensation was drawn—a system which gave rise to innumerable attempts to juggle with the rates. The men drew their food from merchants who lived in the regimental lines known as the regimental bazaar. The Commanding Officer bought all his own clothing and such things as water bottles and haversacks (full dress was supplied by the Army Clothing Department). Incidentally, this meant that while quite a lot of capital was locked up in sealed patterns with each corps, Government had no stocks to finance. The Indian units used to erect, and until the war kept in repair, their own barracks. Now all this was very simple and convenient. Lord Kitchener had recognised that it would not work in war, and meant to scrap it, and when the war came it was all scrapped, and since the war the ordinary methods of provision by Government have continued. It had long been known that the men were inclined

to starve themselves, to send money to their homes unless the regimental authorities kept a very strict watch on their food expenditure, and that the stamina of the Indian, especially of the more frugal Hindus, was always below par from defects in food quantities. The military authorities gladly abandoned a system which, however convenient in its origin, was full of anomalies in modern times. The same applied to clothing. It saved departmental establishments, but took up the time of the regimental officer whose time in these days by no means hangs heavy on his hands. Besides, the regimental authorities had no means of seeing that the textiles they bought were up to standard, or even that the proffered sample was good enough, let alone that supplies were up to sample. It is also obvious that this regimental system neither provided any personnel nor any reserve stocks for working the war system. And it is obvious that an entirely different system and routine in use in peace from that which you will want in war is very poor business. So this in many ways wonderful old India semi-feudal army system has served its time and has now gone. It will interest you to hear, though many know it, that a hundred years ago in India only the piquets actually drew rations. British troops drew a ration through regimental contractors and the Indian troops purchased and cooked their own food individually. Everything was supplied by purchase from the regimental bazaars, which followed the Army with a horde of scratch transport and pitched and struck their camp in a regular place by signal from the Bazaar-Master's flag. It was a well understood principle from the earliest Indian days, and the Army followed the rule and routine which had obtained in the huge moving camps and retinues which accompanied the migrations of the Mughal emperors in their great treks between Agra, Delhi, Lahore and Kabul. The great tribe of Brinjaras, the pack transport of India armed for their own protection, brought supplies from the network of Indian merchants to their relatives and partners in the camps. It was to protect this system and the moving bazaars which was the principal reason for the evolution of the large force of irregular cavalry of the days of Lord Lake. In the same way, the country being largely uncultivated fodder was cut and scraped from the country side and every one had their host of grass cutters. This system of the Mughal times has only died out within the last ten years, forced out by the railway and the canal. It is a very romantic and interesting story and has never yet been told, and is mixed up with the story of commissariat agents which I have not time to tell you of.

So you will see that the modern Army housekeeper has a much larger business in India than formerly.

The Purchase of Food.

The purchase of food is a simple problem in Great Britain and a com-

plicated problem in India. In Great Britain contracts are often placed on an "as required" basis, and it is only necessary to see that the goods supplied daily by the contractors are of the contract standard. The officers of the Royal Army Service Corps are highly competent in the quality of food, while the modern grading and inspection of food staples much simplified their purchase. Distances are so short in this country that the matter is simple. You are always within hail of contractors. Food laboratories are easily obtained and samples of grain can be taken for their food value and further analyses show if that standard is being maintained. In the same way there is no difficulty in having your oils and petrols tested.

In India the fresh supplies, such as meat and vegetables, are easily purchased under the same system. But in a country where rains may fail at any moment the contract system is often vitiated as regards value by the fact that the contractor cannot possibly supply at the contract price. He prays for some relief. The financial authorities would rather see him burn than agree, and I have found myself fighting the battles of Indian contractors, of all people, on the ground that they will generally produce something for you at great loss rather than let you down, trusting to get some consideration from Government. In the interest of the troops who would go without if this spirit were killed through the contractors being treated too strictly according to their contract, I have supported the contractor. There is a human side in these matters that must not be forgotten.

Now here is a very interesting point with regard to beef in India, which hardly anyone outside the Quartermaster-General's people understand. It has a political value as well as an economic point. The Hindu, as you know, has a very genuine religious horror of the slaughter of kine. The Moslem who likes beef and who number 80 out of 315 millions does not care, and having been the ruling race is not going to be deprived. The most that he will do (by order of the police) is to slaughter the kine out of sight of Hindus. Constantly have I been called on to answer questions for the Indian Assembly as to why such valuable things as cattle are slaughtered for food when dairy and draught cattle are deficient in the country. The real story is a curious one. No one in the length or breadth of India grows cattle as an industry for the meat market. There is no one who buys store cattle to fatten or who rears slaughter cattle. The supply of beef which your British soldier gets and which is always a source of agitation, sometimes genuine, sometimes only to annoy, and the beef which the Moslem eats, comes from two sources. The Hindu farmer sells his barren cows, which he must not kill, to save keep and get the value of the hide, to a Muhammadan meat grazier. His conscience is salved. That is one source of supply. The other is intractable or lame bullocks, which cannot be worked in cart or plough. They, too, must not be killed by their Hindu owners, so they are turned loose to wander about ownerless, or are sold for a few rupees

to Muhammadan meat contractors or meat graziers. Beef, therefore, is a by-product and for that reason is still sold at about threepence a pound. In years gone by I have often bought it for a penny a pound—not very good beef, but you won't get better unless you get it fed on grain for a considerable time at a prohibitive price. The only good beef you used to get in India and you can't get that now was when a battery bullock broke its leg on parade and was shot and sold. The battery bullock lived on a good grain ration. There is a small business of late years of fattening beef for sale at Simla and elsewhere at a very high price. The source of the animals is still the barren cow or the wild or lame bullock. The price of beef for the reasons I have explained makes it impossible to feed the Army on frozen beef, even if such were available, without a very large increment in the cost of feeding the British soldier.

The purchase of grain in India is also an interesting business problem. The Indian soldier lives largely in these days on whole meal, whether he serves north, south, east, or west. The wheat in India is only produced in certain districts far away from where it is required. Further, it usually happens that the food which the Indian soldiers of the north require is not eaten by the inhabitants of the country they are stationed in. Instead therefore of buying it from local contractors who have to buy, bring, and store it from the wheat markets, which are only at Lahore, Delhi, or Lucknow, it is better to buy oneself at the markets, getting the market prices, and to grind it oneself in "controlled" mills where it cannot be changed at nurse for inferior flour. Flour for British soldiers' bread is treated in the same way. Ghee, the great butter ration on which the Indian lives and sets such store, is the most adulterated product in India. It is produced in certain localities only in large quantities where buffaloes find plenty of fodder, the West of India especially. The Army has to boil, clean and test all it gets and then tin and distribute. I could tell you stories that would astonish you about the adventures of samples going to the food laboratory at Kasauli and the attempts of contractors to get the sample changed in the post for a better one. Such a network of roguery surrounds every transaction in India.

The Q.M.G. in India has a food laboratory of his own, as there are none such available for his use otherwise. Where tinned food, such as milk and beef, have to be kept in reserve, the laboratory saves many thousands of pounds, in telling him which date of manufacture is within measurable distance of deterioration and should be used before it goes bad. Stores of this sort deteriorate sadly in the East. Ghee also deteriorates. After the war I had one-and-a-half million pounds worth of ghee on hand, and only by the constant attention of the laboratory were we able to use this without heavy losses. Ghee can only be produced at certain seasons of the year when grazing is lush and large stocks have to be laid in each season. I

tell you these details to show you how the change of policy in regard to the feeding of the Indian Army has thrown a varied and strange duty on to army authorities and that food provision in India is quite a different problem from food in this country. An added anxiety is so to arrange your storage and purchase in a manner to minimise the chance of rumours spreading of adulteration for religious defilement, which were so rife in 1857.

FODDER AND DAIRIES IN INDIA.

I have told you so much of the food difficulties that one of the exceptions where the Army has to produce its own requirements will interest you. No one grows hay in India and there are no meadows and very little real pasturage. The Army Authorities used to get their hay from contractors who cut the grass in the forest reserves, grass which only grew when the rains were good, and which was always saved too late to be nourishing. Or else hordes of grass cutters were kept who scoured the country on their ponies scraping up the little *Uariali* grass from the edges of canals and ditches—very nourishing, very insanitary and prolific of contagious disease, and often not obtainable. Government in time of drought had to expend enormous sums in fodder. They, therefore, started a farms department to conserve and harvest the grass growing in good years on Army land, to harvest in due season the grass on Government forest reserves, to create large stacked reserves in good years. The results have been very wonderful in assuring a certain supply in all years, and even in feeding the cattle of the civil population in years of drought.

As no one keeps decent cows and feeds them properly, except a few enterprising folk at some of the big stations, the Government, in view of the severe outbreaks of enteric fever that used to devastate our cantoments, started military dairies and large dairy herds—an interesting and successful enterprise, which, however, soon brought you into the same sort of troubles as, let us say, the Tramways and the Buses have brought the L.C.C. and the Government in London. Having spent a large sum in establishing a model dairy for, say, 5,000 British soldiers and their families, the Army was not going to allow a rival civilian business to set up in the station, when it would not come forward earlier and save the Army starting at all. You will at once realise the sort of agitation that follows.

Here is an interesting story on economics. During the war the British troops in India and in Mesopotamia could not get cheese from the ordinary sources. The Military Farms Department was told to make cheese, and it started a large cheese factory in the old deserted cantonment of Karnaul, which had good grazing and a good buffalo neighbourhood. It made large quantities of very fair cheddar cheese. It also had a flourishing ancillary piggery attached, to use up its skim. When the war was over and it was my fate to take over the duties of Q.M.G., I found this very model " cheesery "

flourishing. I wanted to keep it on and supply the Army with cheese, but I found that, the moment economic laws were at work and New Zealand or Australia could tender again, it was impossible to produce cheese in India, despite cheap labour, at a competitive price. Why? Exactly for the same reason that we get good cheap New Zealand butter here now. They have all the year round grazing. We have not got it here, and India has none of any value for good cattle. We have to stall feed, and up goes the price of your cheese. So I had to close down an otherwise admirably organised business. It involves the great principle of private against State enterprise. In State enterprise your losses are paid from the rates or taxes. Trying to run on an economic system I could not continue operations when trade could do it well enough at less cost.

Well, gentlemen, that I think is enough about food.

Horse Provision in Great Britain and India.

I must give you a short outline of another of the duties of the Q.M.G., though it would afford scope for more than one lecture in itself. I mean the provision of horses and transport animals. I will only touch on the main business principles for they are often forgotten. For India horses are largely bought in Australia, because Indian soil and food and industry did not produce horses of military stamina in sufficient quantities. In the days of John Company the Army had to use largely the horses of Central Asia and could neither draw powerful guns with horses nor carry the equipment and ammunition that a modern soldier needs.

But the top of the market, the best horses that India can supply, go to the Army. I mention this first because in this country the opposite has always been the case. The top of the riding market for the half-bred horse is the hunting field, the 200 guinea horse, for sale here or on the continent. But no breeder will get this result from every foal—perhaps one in three or four, at best. He must sell the residue at a price that will help average his losses or the profits which he makes on his successes. The hunter misfit has always made the Army troop horse, often own brother or sister to the 200 guinea horse. And they used to be sold, and I daresay are still, to the continent also, when the British Army has had all it wants. There used to be a childish coutcry that the foreigners took our best horses. They only did so so far as it was our trade to breed best horses for them to buy and misfits for their cavalry. A horse breeder's business is to breed to sell, and the more continental buyers there are the more horses are, and used to be, bred. Of course, the rise of petrol has altered matters terribly, especially as regards the van horse for artillery purposes. Up till recently the trade bred horses and the Army bought what it wanted. There was no need to stimulate it except in the matter of sires, and there was no need to buy young stock because the breeder could not sell till his stuff was getting

towards maturity, and, therefore, it was better for him to hold the baby than you. All you have to do is to see that the business is not a dying one. Directly a business is not kept alive by the requirements of civil life, the Army or the nation has to step in if its products are still required. Now in India again things are very different. There are no fields and paddocks, and the breeder has to tie up his young stock or he gets into trouble with his own or his neighbour's cornland. Therefore, the Army buys yearlings and two-year-olds, and has large runs, to prevent the stock from growing stunted and narrow-chested. She has an elaborate system of sires and approved mares, because she wants to breed Army horses, to lessen the money spent on horses out of her own country, and also to have a larger produce of good misfits which the Army does not want for civil requirements. You see at once the essential difference between a country where the Army is the top of the market and where it is not, and where breeders must and can run their stock till maturity and where they can't. This is only the fringe of a large and fascinating subject, but as I am trying to talk on the business aspects of an Army, I have just tried to bring out the main business points of the subject. Fortunately the mechanicalization of artillery has come more or less at the same time as the mechanicalization of civil life, so that the Army will not be severely handicapped by the question of the artillery draught horse, whose departure so many of us who have been gunners lament so much.

Curiously enough in Australia the coming of the "tin lizzie' is driving out the riding horses and only the expensive polo pony will be bred, while the artillery type of horse is still in great demand.

Conclusion.

It only now remains for me to apologise if I have taken you at too fast a gallop over a very large and wide subject or series of subjects, but my object has been to give you some idea of what Army housekeeping and provision is, and how much involved it is with every phase of Army life, amd with victory in war, as well as how it touches every phase of business life and how the eternal hard facts of business and economy have to be considered and abided by.

DISCUSSION.

Sir George Buchanan, K.C.I.E., M.Inst.T., said he would like to express his appreciation and thanks to General MacMunn for his intensely interesting paper. Very few people knew anything about the business side of an Army, or what went on behind the lines, and he would like to suggest to General MacMunn that he would be doing a public service in getting in touch with the British Broadcasting Company and broadcasting his lecture throughout the country. He (the speaker) had had

the privilege of serving under General MacMunn in Mesopotamia when he was Inspector-General of Communications, and he thought he had come at a most opportune moment; indeed, he would go so far as to say that if it had not been for General MacMunn the Army would not have arrived at Bagdad as soon as it did. He (the speaker) was sent to Mesopotamia at the end of 1915, after the Battle of Ctesiphon. He was not a professional soldier, and he was afraid he was looked upon as perhaps a harmless intruder. At any rate, the key to the situation was communications and transport, and after he had looked round it was obvious that under the existing arrangements it was only the gallantry of the British Army that permitted any advance to be made at all from Basra. Then General MacMunn appeared on the scene, and with his boundless enthusiasm and great powers of organisation the Army got a move on in every direction, with the result which the world knew. General MacMunn had said that he could tell stories that would make angels weep, but he had not told them to that audience. He (the speaker) would tell a story which made those concerned weep at the time, but which now might possibly raise a smile. When they were struggling in Mesopotamia, a ship was sent from Bombay with a large amount of heavy machinery. The people in Bombay were very thoughtful; they said, "There are no cranes up in Basra; the ship is not properly equipped with lifting appliances; we will send a crane;" so they sent with the ship a powerful hand derrick crane. In due course the ship arrived, but the crane was at the bottom of the ship, and all the heavy machinery was on the top, so that the ship had to go back again to unload and the position of the crane and the cargo reversed! That story could be multiplied many times but in spite of everything we did win the war.

Sir Selwyn Howe Fremantle, C.S.I., C.I.E., said that he had had a good deal to do at different times with the business side of the Army. As one of the Provincial Controllers of Munitions during the war, part of his duties had been to assist the military side in the matter of supplies, and he had had some talk with the lecturer's predecessor on the subject, and also with some of the members of the Quartermaster-General's staff in India. There were various things in which he thought he was of some little assistance to them. There was a great idea at that time if one gave a contract for a very large quantity of any commodity, one got it on lower terms than if one gave small contracts. That no doubt might be the case in England, but he did not think it was at all the case in India, because during the war there were so very few people who could afford to take large contracts that they formed a ring, and the only way to get round that ring was to get hold of the smaller men. India was a country with very little enterprise, and he remembered being told at the time that they could not get any jam for the troops in India at less than 9 or 10 annas a pound. The authorities were quite ready to pay, he thought, 8 annas, and they could get it from Australia at about 6d. or 6 annas, but the difficulty in getting it from Australia was that at that time the sea was very unsafe, and there was no shipping, and therefore they tried to get it in India at this higher price, and people actually began to lay down Cape gooseberries and to try to produce other fruit; and then the war came to an end. It was very interesting to him to hear about the particular commodities which the Army found it had to produce for itself, because about fifteen years ago Lord Morley got the idea that the production of hay and milk was interfering with private enterprise and ought to be stopped; and he (the speaker) was put on with a Colonel of the Military Accounts to go round and inquire into the financial results of grass farms and dairy farms. He thought they were sent to curse, but they remained to bless the scheme, which was

then only in its infancy, of producing the hay and the milk. The fact was that if one had not got a good stock of hay behind one, one was at the mercy of the contractors, whereas if one had a year's supply in stock, then one could make one's own terms and could produce milk on the whole very much cheaper than if one allowed one's self to be in the contractors' hands. The matter of milk, of course, was one of hygiene. At that time many regiments had their regimental dairies, and none of them, he thought, were really sanitary according to modern ideas. The result of that inquiry was that the business of producing milk was put on a very much more businesslike footing, and now it was quite true, as Sir George MacMunn had said, that the Army had some of the best milk-producing herds in India. There was one cow at Lucknow, where he had recently come from, which was giving over 50 lbs of milk a day, which was an exceedingly good record.

He had been very much interested, and he was sure all of those present had been, in what Sir George MacMunn had said that evening.

MAJOR-GENERAL S. H. POWELL, C.B., said that he would like to touch on one point which seemed to him to affect very much the business of the Army and that was the question of waste. Everything that an Army consumed—and in a good many years of active service he had always been a consumer, and not a manufacturer or supplier—had to be carried up from its base, and everything that was wasted at the front meant that so many other things which were wanted had not been carried forward. When one passed from peace conditions to service conditions, people who had served in peace and had made every pound do the work of two, suddenly found that restrictions of their demands had fallen from them, and they did not quite know how to behave; and the result was that the waste was so portentous that he would like Sir George MacMunn, if he was going to add a few more words on that point, to say what he thought was the fraction, or approximately the fraction, for what was wasted in war; because every item that was wasted meant that something else was denied unnecessarily to people who wanted it; and he had suffered very terribly from that in the field. He thought that the business of an Army was not complete unless that question was dealt with, although it was frequently forgotten.

COLONEL C. BAILEY said he happened to have been in Basra just before Sir George MacMunn's arrival. He also was a brother staff officer of Sir George's; they had served together on the frontier and at various other places. He was Base Commandant at Basra when they had at first two Divisions, and they had to work with the most extraordinary difficulty. Sir George MacMunn had said that he was sent there with a free hand and told to spend. Well, before that time they were in just the opposite position: nobody would give them any moeny at all, and they could not get anything in his time. He had been told to run the whole of the disembarkation, for instance, with one staff officer, and some of those present no doubt knew what the river front was, extending for many miles. He could not even get a motor boat for the M.L.O. to go about among the ships, and there was no quay in those days, as there was at present; the ships were all out in the middle of the river, and so it meant some work. Then Sir George came along, and, of course, things were very different. He himself had been what Sir George called "head housekeeper" for the whole Army for a time up at Kut; he knew that they were then trying to get together sufficient river transport, but it was almost impossible to get anything at that time, and people had not been prepared for such a tremendous run on supplies. The consequence was that when they wanted them in a hurry,

and they wanted to go on with, he thought, three or four Divisions, with which the advance was to be made, they had not any more transport than they had had for two Divisions. They could not get steamers of small draught from anywhere although they had tried all over the world. Some of them were coming along, and had sunk on the way; so one could imagine the difficulties they had to contend with. When Sir George MacMunn arrived he had a free hand, and was able to make quays and railways and all sorts of things, and that enabled this Army to get on as it did. It had been most interesting to him to hear all that Sir George MacMunn had had to do after his arrival.

There was just one other point which he would like to mention, and that was with regard to the silladar cavalry in India. He had commanded one of those regiments, and, of course, he quite agreed that in war time, in modern war, the system could not hold because of the difficulties in the field; but in his time and in the old days it was really a wonderful organisation. When foreign officers had come over they were perfectly flabbergasted; they had asked how on earth it was possible to do it. They had seen regiments of cavalry going by one after the other, well equipped, well horsed, and they had said, "Do you mean to say you pay for all this?" The men got about £2 10s. a month, and they provided everything for themselves. It was really a large business concern which depended entirely on the Commanding Officer, and if your Commanding Officer was no good you had no money and bad equipment. Sir George MacMunn had said, "The Army ought to produce its own requirements." His own regiment did that as much as possible; they had their own mills instead of having their flour ground, and so on. He (the speaker) was one of the first people to abolish the old regimental bunnias. He would like to add his congratulations to Sir George MacMunn on his most interesting lecture.

The Chairman said that it devolved upon him as Chairman—and he felt sure he was echoing what was in everyone's mind—to propose a very hearty vote of thanks to Sir George MacMunn for the lecture that he had given them that evening. He would just like to mention one or two things which Sir George had brought to his mind. On the question of meat, he had happened to be a Territorial Captain in India in 1915, and he was up at Jutogh. He only had two subalterns, and so he used to take on the morning inspection of meat, to which General MacMunn had alluded, in his turn, and one of the things that impressed him was the hopeless character of the meat which was being supplied to the British troops. It was all bone and muscle and no fat, and had apparently no nutritive qualities whatever, and when he had become Viceroy one of the first things he did had been to inquire into the matter and see whether it was not possible to supply something better. He had found himself at once up against an economic difficulty, to which Sir George MacMunn had alluded. He had been told that the contract price to the Peshawar Division was 1½d. per lb., and that if one went outside India, as they would have had to do, to places such as Australia or New Zealand, it would be 1s. or more per lb. Of course, this was out of the question, but he entirely agreed with Sir George MacMunn that the quality of the meat which was supplied was very poor. If one saw the legs of mutton, they were really about as big as an English hare's leg! It had been a most amazing revelation to him of the quality of the meat which was supplied to the British Army.

Then he had also been interested to hear some things which Sir George MacMunn had said, and another observation which had been made by General Powell, on the subject of waste. When he went out in 1916, Kut was just on the point of

falling, and there was a great outcry against the breakdown in the Medical Department, and he had got rid of the restrictions which had been put by the Finance Department on the expenditure of money by the doctors. A doctor could not, under the old system, get on his own account, even though they were urgently required, medical supplies for more than a very limited sum—a few hundred rupees, even if it was as much as that. He had removed all restrictions and said that doctors, if they felt that things were required for the soldiers, must get them, and the Finance Department would foot the bill. That went on, and of course, as Sir George MacMunn had said, one must spend money in time of war if it was required, but they had experienced the removal of that restriction for about six months after the war ended, and they found that the doctors were so running amok with their expenditure that they had had to reimpose the restriction. It was quite right; one could not let one's military man run amok with expenditure; one had to keep one's eye on him, and although, when it came to a time of war, he had got to have what he wanted, the Finance Department had to keep a very careful watch over him in time of peace.

Sir George MacMunn had told them, of course, the old familiar things, that supplies must depend upon policy, and he had read with interest those admirable volumes, the Official History of the War in Mesopotamia, which had been written by General Moberly; and he thought one of the most striking things in those volumes, which were scrupulously restrained in their criticism, was that so far as the Mesopotamian campaign was concerned, certainly at the beginning, no one had any policy with regard to what that campaign was to be. It went out merely as a Division, primarily to protect the oilfields at Ahwaz, with no idea of an advance on Bagdad. Well, one could not expect the Q.M.G.'s side to be prepared under those conditions for a campaign which might be launched after consideration of a day or two by the statesmen responsible for the policy. That was the beginning. In the third volume of that history, which had just appeared, it would be found that even when General Maude had turned the flank of the Turks at Kut and had forced them to retire there were one or two days when he had not got orders from home as to what his policy was to be—whether he was to advance on Bagdad or whether he was merely to take up a sort of defensive position as against the Turkish forces in Mesopotamia. Everything, of course, must depend upon policy, and it was no use blaming the soldiers, because it was the statesmen who had got to make up their minds as to policy. The soldiers would carry out their job if they were told what the policy of the statesmen was, and consequently, as regards the Q.M.G., as he had mentioned,—and Sir George MacMunn had not contradicted him,—Sir George did not know on February 27th that there was any idea of an advance on Bagdad, and yet he was able to promise General Maude that by March 5th he would be ready with the supplies to enable him to make that advance.

There was only one other thing he wanted to say about Sir George MacMunn. It would be remembered, when he was talking about the soldier and the civilian he went away at the end saying, "Thank heaven, those devils do not know everything." It was just because the finance man always felt that the soldier or the sailor was going away saying that, that he would not give the game away. He was sure, if Sir George MacMunn's observation to-night were published broadcast in the papers to-morrow, the Treasury in England and the Finance Department in India would keep a much closer eye than they did now on the spending departments!

The vote of thanks was put to the meeting and carried unanimously.

LIEUT.-GENERAL SIR GEORGE MACMUNN, in reply, said that he must first of all thank those present for the very hearty vote of thanks they had passed, which he appreciated very much.

General Powell had raised the question of waste. There were now in the Army, he was happy to say, considerable regulations which were rubbed in to try and endeavour to teach all ranks the importance of not wasting things, and there was to be, whenever Britain went to war again, the same organisation, which was evolved at the end of the last war, of salvage corps under the Department of Ordnance Stores which would become part of the regular service behind the lines for the saving of part-worn and derelict stores, so that they could be re-converted as near to the front as possible for use again, particularly in the case of supplies of such matters as boots. Of course, in the last war, they had had extraordinary results from the sale of grease and the invention of grease traps, which saved the country thousands and tens of thousands of pounds. But how far one could discipline and deal with human nature, and compel an officer and a soldier who was marching hard and fighting and dying, to save materials of war, was a very difficult problem. He did hope that the question of avoiding unnecessary waste, and not drawing more than one wanted, would be borne in mind, but of course, human nature was a very difficult thing. Lord Kitchener at one time had said he was going to make every one in the Army think of those things; he had established stringent regulations; but the Army had said, "Oh, no." Human nature does not like that. Their point of view was that if they did not use what they drew their estimates would be cut down.

Lord Chelmsford had spoken about his experience when he was for some time regimental officer of a Territorial company in India, and how he saw things from the soldier's point of view, and how struck he was—and very rightly struck—with the extraordinary bad quality of the cheap beef, the product, as he had already said, of the barren cow and the intractable bullock. Well, there was not much of a half-way house. They had either got to have that meat, or the stall-fed grain-fed meat which he only knew of in a battery bullock. The only good beef he had ever had in India was when one of the unfortunate draught bullocks had been good enough to break its leg and had to be destroyed. He had taken up that question himself, and he certainly thought that nowadays the Army got a good deal better meat ration than that which the Viceroy had seen when he was there, because one could pay a little better price and make it worth the contractor's while to graze the meat a bit longer. There was all the difference in the world between meat which had been grazed for six weeks and meat which had only been grazed for a week or so. In the old days, if the issue of meat was rejected, one had to wait for breakfast until 2 or 3 o'clock in the afternoon, but nowadays they had got arrangements whereby every regiment could keep up a certain supply of preserved meat and other foods, so that if the contractor produced bad meat, and it was rejected, an issue could be made from the alternative store, and in that way one did not have to wait until the afternoon for the first meal of the day.

ECONOMIC CONDITIONS IN VENEZUELA.

Reporting on the economic conditions in Venezuela, H.M. Consul at Caracas states that the situation in that country at the present moment may be considered as very satisfactory. The development of the petroleum industry has brought wealth to the country, whilst the régime of President Gomez has given Venezuela a measure of peace and prosperity such as it has rarely before enjoyed. Everywhere things seem to be developing in the right direction; and if the internal peace of

the country can be preserved—and there seems no reason why it should not be—a continuance of the forward movement can be expected.

Venezuela is a country of possibilities; she is well provided with minerals and is rich in agriculture and cattle. One of the first steps towards expansion and development should be the improving of internal communications: of this the Government is fully aware and particular attention is being paid to road construction. A great drawback, which constitutes a serious problem now that the petroleum industry is making such rapid strides, is the scarcity of labour. For a country with an area of nearly 400,000 square miles, a population of only two and a half millions is manifestly insufficient. Health conditions, however, are undoubtedly improving, so that the difficulty of attracting sufficient foreign labour may be gradually overcome. Another serious problem is that of the water-borne transport on the Lake of Maracaibo and on the Orinoco river.

There is, however, good reason to be optimistic concerning the future of Venezuela. More than ever, now, is it important that she should not be neglected by British interests; British capital and hard work helped her in the beginning—many of the first public utility companies, such as railways, electric light, telephone and tramway services, were British enterprises, and now, in addition, there are very large British oil interests. No effort, therefore, should be spared to maintain and improve Great Britain's position.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK:

MONDAY, MAY 31..University of London, at University College, Gower Street, W.C. 5 p.m. Prof. Sir Richard Lodge, "Modern English Historians (IV) Lecky."

5.30 p.m. Prof. Dr. J. B. Collingwood, "The Influence of Water on Vital Processes." (Lecture VIII).

5.30 p.m. Prof. Niels Bjerrum, "The New Aspect of Strong Electrolytes." (In English). (Lecture III).

At the Imperial College—Royal School of Mines, South Kensington, S.W. 5.15 p.m. Prof. L. Denoël, "Tubbing Deep Shafts and Subsidence." (In English). (Lecture I).

At the London School of Economics, Aldwych, W.C. 5 p.m. Prof. T. H. Pear, "Fitness for Work." (Lecture I.)

Surveyors' Institution, 12, Great George Street, S.W., 5 p.m., Annual General Meeting.

TUESDAY, JUNE 1..Illuminating Engineering Society, at the Royal Society of Arts, Adelphi, W.C. 7 p.m. Mr. J. W. T. Walsh, "Research in Illumination."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir Percy Sykes, "Shah Abbas, Contemporary of Queen Elizabeth."

University of London, at King's College, Strand, W.C. 4.30 p.m. Dr. J. W. Pickering, "The Constituents and Coagulation of Blood Plasma." (Lecture II).

At the Imperial College—Royal School of Mines, South Kensington, S.W. 5.15 p.m. Prof. L. Denoël, "Tubbing Deep Shafts and Subsidence." (In English). (Lecture II).

At the London School of Economics, Aldwych, W.C. 5 p.m. Prof. T. H. Pear, "Fitness for Work." (Lecture II).

At the Institute of Historical Research, Malet Street, W.C. 3 p.m. Prof. Janko Lavrin, "Chekhov and Maupassant."

WEDNESDAY, JUNE 2..Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 6 p.m. Mr. P. W. Willans, "Low-Frequency Intervalve Transformer."

University of London, at the Imperial College, Royal School of Mines, South Kensington, S.W. 5.15 p.m. Prof. L. Denoël, "Tubbing Deep Shafts and Subsidence." (In English). (Lecture III).

At Trinity College of Music, Mandeville Place, W. 5.15 p.m. Dr. Stanley Marchant, "Modern Chamber Music."

At the London School of Economics, Aldwych, W.C. 5 p.m. Prof. T. H. Pear, "Fitness for Work." (Lecture III).

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. A. J. Toynbee, "The International History of the Modern Islamic World." (Lecture I).

Public Analysts, Society of, Burlington House, W. 8 p.m. Mr. Alfred Lucas, "Problems in connection with Ancient Egyptian Materials".

THURSDAY, JUNE 3..Chemical Society, Burlington House, W. 8 p.m.

Chadwick Public Lecture, at Chelsea Physic Garden, S.W. 5 p.m. Prof. J. McLean Thompson, "The Plant as a Sanitary Engineer."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. J. Newton Friend, "Iron in Antiquity."

Royal Society, Burlington House, W. 4.30 p.m.

University of London, at the Imperial College—Royal School of Mines, South Kensington, S.W. 5.15 p.m. Prof. L. Denoël, "Tubbing Deep Shafts and Subsidence." (In English). (Lecture IV).

FRIDAY, JUNE 4..Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Prof. Dr. S. H. Reynolds, "A Geological Tour in South and East Africa."

Philological Society, at University College, Gower Street, W.C. 5 p.m. Mr. C. T. Onions, Dictionary Meeting.

Transport, Institute of, at Midland Hotel, Manchester. 6.30 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. John Garstang, "Researches in Palestine."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. J. A. K. Thomson, "The Development of Irony." (Lecture III).

At the London School of Economics, Aldwych, W.C. 5 p.m. Dr. E. Beddington Behrens, "International Problems of Industry." (Lecture VI).

SATURDAY, JUNE 5..Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Walford Davies, "The Triad and the perfect Fourth." (Lecture II).

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

INDIAN SECTION.

MONDAY, MAY 31st, 1926. BRIGADIER-GENERAL SIR PERCY M. SYKES, K.C.I.E., C.B., C.M.G., in the chair.

A Paper on "The Military Record and Potentialities of the Persian Empire" was read by LIEUTENANT-COLONEL SIR ARNOLD TALBOT WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O.

The paper and discussion will be published in the *Journal* dated July 23rd.

PROCEEDINGS OF THE SOCIETY.

SEVENTEENTH ORDINARY MEETING.

WEDNESDAY, 28TH APRIL, 1926.

BRIG.-GEN. SIR HENRY MAYBURY, K.C.M.G., C.B., M.Inst. C.E., Director General of Roads, Ministry of Transport, in the chair.

THE CHAIRMAN, in introducing the lecturer, said he did not suppose the name of Paterson, associated with Carter Paterson, was unfamiliar to anybody present. If Mr. James Paterson did not know anything about transport, then it was of very little use for anyone else to start talking about it. Carter Paterson had almost a world-wide reputation for efficient handling of transport. One saw the results of their endeavours everywhere. The lecturer was no mean authority on the subject. He had been for a long time a very distinguished member of the Institute of Transport, and it had been his own good fortune to serve with Mr. Paterson there for two or three years. Mr. Paterson was about to bring forward a very interesting economic problem and one which he hoped would result in a good discussion.

The following paper was then read :—

HORSE TRANSPORT AND MOTOR TRANSPORT.

By James Paterson, M.C.

1. Introduction.

This paper only sets out to suggest some of the points that have to be thought of in considering whether, during the next year or two, we can expect the disappearance of the animal for drawing waggons from our cities for economic reasons, and to consider which cities might first experience the complete triumph of the engine, and why.

Any figures that may be given are not supposed to be actual costs, either to-day or at any time; but are used as illustrations only.

We must add, "provided the present costs do not greatly change relatively to one another," because costs have changed so much during the last few years.

Motor cars that used to cost over £1,000 can be bought to-day for little more than half that sum. Commercial petrol was once obtainable at 5¼d. per gallon, and having been as high as 3s. 3d. is now a little over 1s. Tyres, which used to cost 5d. per mile per car, last year cost under a penny.

Hay for horses has fluctuated between £3 and £15 per ton delivered in London; and maize between £5 and £23. Paint for vans from 2s. to 9½d. per lb.; and ironwork from £34 to £8 per ton.

When we paid these prices some of the people who sold made vast profits, but others little or nothing.

Consider the case of maize, and the story of petrol and indiarubber!

He would be wise who could foretell what these costs may be in the next 5 years. In Europe, in the Colonies, or in America these costs may vary from time to time with regard to one another.

Also politics vary in different States causing artificial differences in costs. There might even be restrictive taxation in one case; in another desperate taxation to pay war debts.

2. Transport Geography.

The degree to which human hands have altered the surface of the earth in different places influences our problem.

Old towns in countries like France, England or Spain grew up when animals were the only known mode of land transport. Many streets, like our Bond Street, Watling Street or Lombard Street, and in Seville, the "Calle de las Sierpes" or Kalver Straat in Amsterdam, may be unsuited to motor traffic, and frontage values may be so high that widening can hardly be considered.

The question as to whether one can or cannot get a motor lorry to a warehouse in parts of London still arises to-day; and the number of roads out of New York is so few and their width such that at times cars are so thick that there is hardly more space between them than there is between the ranks of a battalion whose march discipline is good.

Also in older cities there are still stables for horses; the established railways and other carriers have their horses and vans and are naturally averse to the expense of "scrapping" them for something else without good cause shown. Also they have officers, servants and customers used to animals and used to working at the pace of the animal.

In new colonies where towns are growing up, for instance on the Prairie in America, absence of capital means that they generally start with what the Americans call "dirt" roads; and therefore are restricted either to animals like the Alabama mules or to vehicles specially evolved to go on colonial roads, like the "Ford" car.

Similarly in Constantinople not long ago the neglect of road repairs made the human porter almost the only transport practicable; and in Japan, away from the few motor roads, the man with the push cart is the most economic transport unit.

3. Examples of the Effect of Economic Conditions on the Problem.

In Paris there are said to be less than 1,000 horses. Is not that because Paris is a luxury City?

In New York City I gathered that there were last year more draught horses in proportion to commercial motor lorries than there were in London, although, perhaps, less horses altogether (as statistics show).

I venture to suggest as a reason that the carrying of other people's goods from point to point about that City for hire seems to have been very remunerative for some time past and people engaged in that profession have not been forced to make changes in order to make a living.

The difference in the total number of commercial road vehicles proportionate to population may be due to the fact of Manhattan being an island, and to the difference in their railway development.

I except from that general observation the American Railway Express, who are developing their business in the most modern way and who are a marvel to all who have seen their methods.

To give another illustration, in some new cities in the United States one particular make of car may be sometimes almost the only make there, whether for private or business purposes, and even though some other vehicle might be more effective for a particular job, people there might not understand it, might not be able to get spare parts for it and so on, and to introduce another make in those conditions to do some specially heavy work would present as many problems as introducing an elephant.

4. Illustrations from London Suburbs.

The differences between the old town and the new may be illustrated by examples from the London district.

Deptford is an old town; situated about 4 miles South-East of London

Bridge with the victualling yard, and wharves on the Thames and on the creek; a thick population of daily wage-earners, dock hands, sailors and so on, some now living in what used to be charming old houses put up by James, Duke of York, for his Navy Captains, when the Navy Yard was there.

It is surrounded by factories at Charlton and by the districts of New Cross, Greenwich, Lewisham and Lee with Blackheath not far off; all built in the days of horse traffic.

Ealing, surrounded by Acton, Hanwell, Southall, etc., is at an intermediate stage; it is a suburb of some standing with a main line of railway on which it depended for many of its supplies from London, although many also came by road in the days of horses. This suburb has grown in the last 15 years in every way—factories and residences also, thick and fast, as electric trains made travel to and from London possible for the daily wage earners as well as for their Managers and Directors who in former days had it to themselves.

Wealdstone, Northwood and Pinner can be taken as a new colonization of a piece of country; quite different from the town planning of the Great Dukes of the London Squares and of the town of Eastbourne!

5. The Actual Means of Transport Which May be Found in Districts Round London, such as those described above.

Will you now permit me to discuss this in practical detail from the limited point of view with which it is my duty to be familiar; namely, that of transport for local distribution to and from factory to shop and home?

In a place like Deptford before motors were invented, one would have expected to find a carrier's depot with say 150 horses in good stables, the sort that are not readily convertible to motor garages. The clients of the depot were used to being called on by horse-drawn vans, and many of them would be so near the depot that hardly any time would be saved by a quicker moving vehicle. Horses can negotiate the narrow streets and the horses can easily be unhooked from one van and hooked on to another.

May I illustrate this point by the humble manure van?

Stables should be so arranged that manure is put straight into a van. That saves handling and saves the unpleasant smell of turning it over when heated. When full, a horse can easily draw it away and another van can be put in its place and then the full one can be drawn to the railway yard for conveyance to the country.

True, a mechanical horse could now do the same work, but who could tell me where to get one that would do it better or more cheaply? And could it back a van into place as accurately? Would there be any advantage in using a motor lorry with a removable body? Would there not be higher capital outlay, more complications and no saving?

Is not this the reason why some of our railways have two vans to every horse they own?

At such a depot as is being described the number of horses means a continuous week's work for a shoeing smith. It would enable a horse-foreman to be employed with say 12 or more horsekeepers and the wheel-wright would have plenty to do. Shortly, overhead charges would be small " per horse."

Assume that for comparison we can take a man, with horse and van, to carry 25 cwt., as costing £300 yearly—that figure to include an allowance for sick horses, etc., and that for the work they do, two men share a third horse between them, say, £40 each or £340.

Assume that a man with a 40 cwt. motor car costs £550 yearly, three such men and cars would be £1,650, carrying 120 cwt. at one time, that is, £50 less than 5 horse men at £340 (i.e., £1,700) and carrying 125 cwt. at one time. (I do not mean to convey that these are true costs, but they are given just to help the argument).

Could the 3 men with motors do the work of the 5 horse men? remembering that the 5 vans are standing still, collecting or delivering about half their working day—leaving only the other half during which the greater speed of the car could count; also remembering that just near closing time, when all clients want the carrier's van at the same moment, the 5 horse vans can be in 5 places at once against only 3 with the motors.

Also with 5 men the carrier has 5 personalities working with him. Would he be wise to reduce those to 3?

Further, if 7 or 8 horses and 5 vans were "scrapped" and motors bought (at a further investment of £1,200 capital), would any actual savings in overhead charges result? Would not the "overhead" come out at more per horse on the reduced stud?

And can anyone be sure that the figuring he does as to costs will come out correctly for a sufficient number of years ahead to justify his making a change? Would a rise in the price of petrol, or a change in the price of hay and maize, or a miscalculation in the life of a horse or motor upset his expectations?

There is a fleet of over 30 4-ton petrol lorries now running efficiently in London which were bought over 17 years ago and whose cost was written off in about the first 7 years of their life! They have each run over 220,000 miles. Will a modern car last 7 or 27 years?

6. The Intermediate Sub-Town at Ealing and Acton.

Here one would have found a small carrier's depot established with horses before the motor came. But some of the outlying parts would have had pair horse vans serving them, sometimes with a reserve pair. There would probably be a clear case on yearly costs for changing to a motor, especially in a growing district, without reducing the number of men.

As the outer districts grew, motors would be added. As the near home district thickened up horses would be added. As factories grew up needing

heavy deliveries rather beyond the range of the horse, electric cars would be introduced, and so we get a mixed fleet.

But this depot has to be visited, both by the veterinary surgeon and the mechanical engineer; it would need, say, a 2,000 gallon petrol tank and an electric transformer and to share a shoeing smith with another depot, so that overhead costs would be probably above their minimum.

From what I hear and read, however, I gather that most people think that there is a definite place for the horse; a definite place for the electric; and a definite place for the petrol car and that all may subsist side by side for many years to come, if circumstances remain unchanged. If they are right, then have I described a properly equipped depot or not?

7. The New Town.

Wealdstone and Northwood have grown up since the invention of motors and it was therefore natural that the distribution equipment provided for that district should be motors, because it started as an "outside place" to a depot in one of the older suburbs. When it grew to need its own depot, an "all motor" depot would be installed, at a higher capital cost per unit of movement than ever before in the owning Company's experience.

True, no veterinary surgeon or shoeing smith would visit that depot, but in theory there would be one or two jobs that would be done more cheaply (according to present costs) by horses.

8. What is the Sphere of the Horse?

I am relying on the "discussers" of this paper to advise what to do in the condition described as "Deptford."

Is the horse still the most economical and efficient unit there? or can a good case be made out for the raising of many thousands of pounds to "scrap" them? If so, what is recommended in their place and why?

9. Speculation on the Sphere of the Electric Car.

In the intermediate suburb could not the electric do all the work?

Why not replace all horses by electrics, just a little bigger than the horse van and filled with batteries to carry them up to 20 miles a day during which they stop and start 100 times? These ought not to cost more than the horse and harness costs to buy; these electrics might be geared to go not over 15 miles per hour; and could the chassis part be made to cost not more than does a modern horse van, one that is steel-covered with ball bearings, say £120, or little more—and at a cost for use of charging plant and electric current of less than the horse costs to feed? Is this too difficult a task to set the electric vehicle engineer?

So one would use home produced fuel instead of importing maize (which is humans' food) and instead of taking up some part of our very small agricul-

tural land in growing the other foods horses need, when it is already too small to grow food for our people.

Are there other parts of our Empire equally suitable for producing our Army transport horses ?

Then, why not replace the petrol cars on the longer journeys by electrics? At a suitable point in their round they could have their depleted batteries withdrawn at a local charging station and replaced by freshly-charged batteries pushed into place by the power of an electric warehouse truck, on which they would be brought from the garage to the side of the car.

Really good battery changing arrangements would enable smaller batteries to be carried and so greater speeds could be attained, and a quick run home at night ensured.

Could one so have an all-electric depot in a not too scattered suburb ? Think of the cleanliness and silence ! Men of over middle age prosper as electric car drivers ; on a petrol car their nerves and tempers sometimes get frayed.

10. Speculation as to the Sphere of the Petrol Car.

We have petrol engines of many sizes, and many horse powers. If we desire to substitute an engine for the power of one or two horses, can we not use one to put out just a little more energy than one or two good horses and to weigh and consume less than they do ?

Could we not add a small petrol engine to a chassis not much different from a modern horse van with ball bearings and steel sides, etc., and adding to the cost of it even less than the horse and his harness ; and costing less per week to operate than the horse does to feed, stable and keep ?

If so, where is the sphere for the horse ?

True, we should still have this buying of imported petrol, unless our native coal can be converted.

We must also consider the present agreement in this country as to wages between masters and men whereby a motor driver gets several shillings more each week than a driver of a horse drawing a similar load.

Can the small motor be just so much more efficient as to enable its driver to earn these extra shillings weekly ?

If so, then our drivers get a little more chance of being healthier and happier men. A few shillings more a week could add to his family's share of civilization. It is our duty to make that possible, if we can.

11. Conclusion.

I have spoken from the limited aspect of local distribution services, realizing that the movement of large quantities between two points may raise different problems arising from the factors of time and distance, and also those of the amount that can be dealt with by one man. Everyone who travelled in an old

horse omnibus will readily realize how many more passengers are dealt with by two men, both per hour and per mile, with a motor than ever were in the days of horses.

Little reference has been made to politics, which may be invoked for and against the animal on many grounds, but those who claim that street congestion is caused either by a slow moving horse vehicle or a large motor lorry and trailer, should take into consideration that some traffic can only bear the low cost of cheap and slow movement, whether by horse or lorry, and that political action to make that traffic move faster would result in something costing somebody more money than it now costs.

If anyone setting up transport equipment in a new town was flattering enough to ask my opinion as to whether I thought he wanted horses, I should say "Why? Have we not mechanical engines to produce any horse power from ½ to 1,000? What can the horse do for you that the motor cannot?"

"Yes," he might reply, "but for some of the jobs no car, petrol or electric, is made at present to do what I want without undue cost."

Is there sufficient demand for cars built to replace the horse, to enable them to be turned out "wholesale," i.e., is the demand sufficient to enable outsize and undersize motors to be advertised?

If someone who had horses in transport came and said that he thought of changing to motors, and asked for my advice, would not the reply be, "You "must make up your own mind. If you are being persuaded by a motor sales- "man, or your own staff, or by seeing a competitor, take a holiday and think "the thing out for yourself, and until you are absolutely sure, stick to your "horses!"

DISCUSSION.

The Chairman said that Mr. Paterson had told them a good deal, but the audience would agree with him when he said that Mr. Paterson had also asked a very large number of questions. In fact, he could not help thinking that Mr. Paterson had come to the meeting hoping to find some experts who would give him information. Mr. Paterson started by asking the question whether the horse should disappear from our streets. Some thought that at any rate the horse might with advantage be relegated to certain streets, but wild horses would not make him deal with a point of that kind! Mr. Paterson, without knowing it, had paid a compliment to the road engineers and their good work, because he had stated in his paper that there had been a time when motor cars had cost 5d. a mile to run, whereas now they were costing a penny a mile. So that motorists were getting something for their taxes! He did not quite understand what Mr. Paterson had meant when he had visualised the possibility of a tax on railways in order to build roads, but Mr. Roger Gibb was present and he, perhaps, would say how that would be likely to work out. Evidently Mr. Paterson could not have been in Bond Street lately, because he had referred to Bond Street as not being a suitable street for motor transport. In that respect he was not very much at

variance with some of the Bond Street traders. Personally he had had a deputation quite recently from that great street, asking that motor omnibuses should be excluded from it. Mr. Paterson could not have known that motor omnibuses were in that street, otherwise he would not have included Bond Street amongst those streets which were not suited for motor traffic.

He had been interested to hear Mr. Paterson state that at one time he had had a steam vehicle and trailer which had done the work of, and displaced, 20 horses. That would almost appear to justify the action of the Chancellor of the Exchequer the previous day!

The author had referred to his experience in Antwerp where there were different kinds of pavements for different traffic. That also prevailed in England. He had been in Sheffield not very long ago, where he had found a street with granite setts on each side and an asphalt surface in the centre. On enquiry he had been told that the asphalt was considered too slippery for horses; but while standing in the street he had seen a good many horse vehicles come along, and he had noticed that so long as the horses were left alone they found their own way on to the asphalt and would not walk on the granite setts at all. He had asked the City Engineer to take a census for a week of the number of horses upon the road and the number which used the granite setts. He had duly received the information and it was surprising to see how small a proportion of the horse traffic made use of the granite setts. He had asked several people when he had been there to loose their horses' heads and see what they would do, and the horses always got on to the asphalt. He had noticed that there was no lack of foothold on the asphalt so long as the horses were left to themselves. It was very often the driver, and the nerves of the driver, which caused a horse to lose its foothold.

MAJOR-GENERAL S. S. LONG, C.B., said that, as an old horse lover, he viewed with extreme regret the departure of the horse off the streets and out of the countryside, but he must say as one who had studied the subject fairly extensively that he could not fail to see that, except for purposes of pleasure and sport, the day could be very much longer delayed when the horse would be bound to disappear.

Turning to the internal transport in a factory, one saw that factory after factory was gradually eliminating horses from inside employment. At his own factory at Port Sunlight horses had now been replaced by the ordinary small tractors pulling trailers about the yard, and the net result had been that the cost of their internal transport had been reduced by one-half. Similarly, so far as the road was concerned, he was certain that as the motor vehicle became more standardised and, therefore, cheaper, and also as it got to have a more prolonged life, so it would become the cheaper mode of transport. It was not so to-day for all purposes. It certainly was not economical to send motor vehicles to dock sides or to large warehouses or to railway yards where they might have to wait for hours. There was the factor, of course, as Mr. Paterson had pointed out, that there was a ready change-over in the case of horse transport; a horse could be quickly hooked in to another cart; but against that there was the extraordinarily slow speed of the horse vehicle. Therefore, he felt pretty certain that, as motor facilities were improved, the horse was bound to disappear, to the general advantage of the traffic on the road—and that, he thought, would happen within a comparatively few years' time. From a humanitarian point of view he was not at all certain that it was not better that the horse should disappear. The advantages of an electric vehicle were obvious, but at present the inventor had not succeeded in producing an electric vehicle which was sufficiently cheap. That it would come there was

no doubt, and the sooner it did the better as it would mean that we were using our own fuel to supply the power. The important point was for some scientist to invent a fuel which could be produced in this country sufficiently cheaply in order to oust the petrol monopoly, and to eliminate the huge bill for petrol which now had to be paid to foreign countries.

THE CHAIRMAN said he noticed that Mr. Walter Wolsey was present. Mr. Wolsey was a Director of Messrs. Tillings, who had the biggest stud of horses in London.

MR. WALTER WOLSEY said that Mr. Paterson had referred to a steam vehicle which he had employed, which had done the work of 20 horses. Personally he would like some further information on that as he had not been able to find anything of the kind himself. Mr. Paterson had also referred to the possibility of working horse transport and mechanical transport from one and the same depot. From his own experience he could say that such a thing was quite impossible.

One point, which a motor manufacturer would be much better qualified to deal with than himself, was the possible production of a motor vehicle which could be used to displace horse transport now used for short-distance deliveries. In that connection probably they would be nearer arriving at a suitable vehicle when they could get down to some finality in legislation. The difficulties which the manufacturer was faced with to-day were almost overwhelming. He heard rumours of regulations which seemed to be so near coming into operation that he designed vehicles, and he had no sooner got his design ready than other regulations came forward which rendered the whole of his work useless. If there could be some legislation which could deal with construction, speeds and tyres, and then further legislation, which would finally settle the vexed question of the basis of taxation, he thought they would be approaching the day when they might possibly look to the manufacturer to produce such a vehicle as Mr. Paterson thought was desirable.

THE CHAIRMAN said he was sure the audience would be glad to hear Mr. Roger Gibb's views on the question of charging the railways with the maintenance of the roads.

MR. ROGER GIBB said he was not at all sure what Mr. Paterson precisely meant by the remark to which the Chairman had referred. Personally he saw no objection whatsoever to taxing railways by an amount which would pay for the upkeep of the whole of the roads of this country—provided the tax was combined with a subsidy of £100,000,000 a year!

MR. WILLIAM ROGERS said that as a farmer who bred shire horses and used tractors, he desired to say that he could not do without horses and he could not do without tractors; there was room for both. Especially for short journeys horses would take a great deal of replacing. That morning he had taken a bus from the Mansion House to Chancery Lane, and in the course of that short journey he had counted over 80 horses on the street. Therefore London had not quite done without horses yet.

There were notes of interrogation running all through Mr. Paterson's paper, and he was not quite sure whether Mr. Paterson had made up his mind as to which form of traction was the better. In his own opinion tractors could be used where horses could not, and horses could be used where tractors could not. One reason

why he liked to use horses was because he could grow their food himself. In that connection he would like to ask why we could not produce motor spirit in this country. The farmers of this country were prepared to produce potato spirit if they were given the chance and if it was made worth their while to do so.

THE CHAIRMAN asked if that meant another subsidy!

MR. H. J. HOWLEY said that after listening to the paper it had struck him that Mr. Paterson seemed to want someone to invent a machine which was half horse and half motor; he wanted to have a sort of light lorry, with a motor on the back axle, to which he could attach a horse at times and into which he could slip a battery at other times. It was a confusion of ideas. The field for the horse and the field for the motor were two quite separate fields. In the case of the business with which Mr. Paterson was connected they had a very large number of depots dotted all over the Metropolitan area. Those depots were spaced for horse transport. When Mr. Paterson had come to equip those depots with motor transport he had found they were too close together and that the radius which was served by each depot was not sufficient to make the motor vehicle pay. He thought that if Mr. Paterson were starting again he would probably have far fewer depots and a much wider radius. Those who had depots to look after knew the very big standing cost of establishing a very small depot. He himself had been looking into that matter in the case of motor vehicles, and he had come to the conclusion that it cost something like £3,000 a year as a minimum. Therefore, if one reduced the number of depots and could work a bigger radius from fewer depots one considerably reduced the on cost; and, therefore, he thought there was scope for motor vehicles, because with them one could get beyond the radius in which horse traffic could conveniently work.

After listening to the discussion, it appeared to him that the case for the horse was not for drawing or carrying loads, but for standing still. Whereas one might be able to afford to keep a horse standing at the docks or at the railway stations for hours at a stretch, one could not afford to have the more expensive motor lorry standing idle with its more highly paid driver. He ventured to say that the solution of that particular problem could be brought about by an improvement in the methods of accepting delivery at the docks and at the railway stations and of collecting at the various warehouses and works where the material had to be carried to or collected from. For standing still, the horse might be the cheaper mode, but generally, given proper facilities, the motor was cheaper.

MAJOR C. H. W. EDMONDS said Mr. William Rogers had referred to the fact that during a short journey in the City he had counted 80 horses on the streets; he noticed that Mr. Rogers did not say whether they were lying down or not! Personally he lived twelve miles from Charing Cross and he got deliveries to his house by motor which could not possibly come by horse transport. All the big stores delivered in his district. He also lived two miles from a shop, and motor transport had created facilities for delivery in his district which had been more or less impossible before the days of motor transport. He did not know whether it paid the big stores to deliver to such a district by motor, or whether they did so merely for the purposes of advertisement.

He had been looking at some figures about the cost of transport in years gone by, and he would take the opportunity of quoting them, as such a lot was being heard at present about the new taxes on motors. In 1730 a petition had been

presented in regard to some stage coaches in the North. There were 33 stage coaches, the duty on which, together with the duty on the coach servants and the mileage duty, came to £12,000 in the course of a year, in addition to which they had paid £8,005 in tolls, making a grand total of £20,005 for 33 coaches per annum. He did not think the motor omnibuses of to-day paid as much as that. In 1837 the taxing costs, he thought, ran out to over £2,000 per coach.

Rear-Admiral James de Courcy Hamilton, M.V.O. (Director of the Army and Navy Stores and formerly Head of the London Fire Brigade), after giving a brief history of the change over from horse to motor traction in the case of the London Fire Brigade, remarked that for certain purposes horses were cheaper than motors. There was no doubt about it that within a certain radius of action and with continual stopping and starting horses were the cheapest form of traction.

With regard to electrical machines, after having gone very fully into the matter in his commercial capacity, he could say that at present they were not an economical means of transport. If, however, he was connected with a swell firm and wanted to show off and did not mind about spending money, he should certainly use electrical machines.

He considered that the Scammel Company's 6-wheeled lorry was a great advance in the direction of reducing the number of horses, being exceptionally handy and possessing an easily detachable motor, and yet it could not be called a trailer. It disposed the load on each wheel, so that there was less damage to the roads, and should take the place of all four-wheeled trailers towed by another four-wheeled motor, which were a danger to the public and could not go astern if required, and were also difficult to stop suddenly in emergency, besides skidding badly if the roads were slippery.

The Chairman, in moving a very hearty vote of thanks to Mr. Paterson for his lecture, remarked that Mr. Wolsey had said the reason why there was no great development in motor car manufacture was because of the issue of regulations from time to time, which were so difficult to understand and which were so embarrassing. That might be the case, but Mr. Wolsey would probably be surprised to know that only on Monday last he had received a deputation from the Society of Motor Manufacturers and Traders, the burden of whose complaint was that they could not get sufficient regulations issued by the Ministry of Transport to guide them as to what they could or could not do. Mr. Wolsey was a very distinguished member of the Commercial Motor Users' Association, and as he thought there were too many regulations he would suggest that Mr. Wolsey could well be co-opted on to 'the Committee of the Society of Motor Manufacturers and Traders, who thought they had not enough regulations.

Mr. Edmonds had referred to the taxes which were imposed many years ago on stage coaches and had referred to 33 stage coaches. Of course, that had not been the age of travel. When one reflected that in the London area 3,500,000,000 people a year were moving about, it showed what the provision of adequate travelling facilities meant, and how people fed upon what was given to them.

He wondered whether Mr. Paterson in his next paper would state the effects of the "roundabout" scheme upon horses. He wondered whether Mr. Paterson had had a trip round Trafalgar Square. He could conceive that Mr. Paterson would say that such a regulation as was now applied to Trafalgar Square made transport by horses very much more costly owing to its having to go by a very much longer route. He thought it would be agreed that the roundabout system had come to stay and that in certain places it could be considered reasonably successful. People

had asked him why such a system had not been put into vogue before. Any such new scheme involved a very great deal of staff working before one dared to get to the point of trying it out. Nothing succeeded like success, and no one in his position would dare to put in operation something which it was feared might fail.

The vote of thanks was then put and carried with acclamation, and was briefly acknowledged by Mr. Paterson.

The meeting then terminated.

Mr. C. Le M. Gosselin (Managing Director of Messrs. H. Viney and Co., Motor Transport Engineers and Forwarding Agents, Preston,) writes :—

Mr. Paterson's paper is disappointing ; it shews a degree of hesitancy, which is hardly worthy of one so well qualified to lead on such a subject. The discussion was naturally influenced by the paper, and, so far from any serious attempt being made to grapple with the subject of the paper, at times almost assumed an aspect of levity.

No mention whatever was made of the past history of horse and motor transport, the respective work they have performed at different periods in the progress of locomotion, from which some idea can be gleaned of the direction it may take in the near future.

The past history may be summarised very briefly as follows :—Railways, the first effective application of motive power to locomotion, supplemented horses because along certain defined lines they could carry goods and persons in greater volume, more cheaply, and expeditiously than the horse. The horse, however, still acted as the link between the railway line and the factory, etc. This led to the creation of large congested towns around railway termini, causing slums and all sorts of other social problems.

Now the road motor has arrived, and its chief task has been to remove the limitations of transport, peculiar to rail service. Not the least of these is to redistribute the working community over wider areas than has been possible in the past. Assisted by the electrification of suburban railway lines, road transport has already started to carry out the process of spreading our population over wider areas and thus reduce the problems of our congested cities—a task in which it is already making substantial progress.

The achievements of the motor in competition with rail and horse transport working together in the conveyance of bulk transport has already reached such dimensions that the Chancellor in his recent budget speech made repeated reference to the policy of allowing this new form of transport to develop at the risk of damaging the older forms. For the delivery of lighter parcels of goods the motor has already seriously encroached upon the domain of the horse. For mail and parcel deliveries, municipal collection of refuse, fire-engine services, and retail deliveries from shops the motor has established a healthy existence—with the result that the community can move from point to point with greater precision and speed than ever before in history, and can also draw supplies from a wider area with the same advantage that they could obtain from horse transport in the past only over a much smaller area.

Every small shopkeeper who can afford a small service car can now widen his circle of customers and give prompt delivery. Every country dweller along a main road can obtain free and cheap access to a town within 10 or 15 miles, and also obtain supplies delivered by road from that town as quickly and easily as previously he got supplied in the town itself.

Does Mr. Paterson for one moment think that a form of transport that has already done so much for the community in its very brief existence will "boggle" at the difficulties presented by Deptford or any other district that has failed to keep pace with the times? Or does Mr. Paterson seriously fail to believe that within a very short space of time, as time goes, a motor can and will be produced to deal with the fragments of transport as it has already dealt with the body of it?

Lastly, has the author not noticed a growing demand from the working classes for a higher standard of living, which is a call to all employers for more efficient tools to handle? The boy with the spade and bucket gives place to the manure cart, which in turn gives place to the mechanical vehicle—it is written large in the pages of history if Mr. Paterson could read it—and to suggest otherwise is to do poor justice to the powers of invention of those who have already revolutionized our transport methods in this Country within the space of less than 25 years.

With reference to the preceding letter, Mr. Paterson writes:—I agree with Mr. Gosselin that history shows a steady development of the motor vehicle until the sphere left for the horse is very limited; but as far as I have seen in the last two or three years, there has been very little attempt by motor manufacturers to produce a new type of motor which will still further reduce the sphere which still remains for the horse

I tried to make clear the directions in which such a further advance in the motor would have most prospects of success, namely, in the more newly developed parts of the outskirts of the city and that it would seem less likely that the horse's existence would be completely threatened in the centres of great cities which are also ports; although even there, I cannot see why, with the mechanical knowledge we have at our disposal, it should not be possible to produce a self-propelled vehicle at a cost to buy and to operate as indicated in my paper.

THE REPUBLIC OF PARAGUAY

His Majesty's Chargé d'Affaires at Asuncion prefaces his annual Report on the Economic and Financial Conditions in Paraguay with the following general information regarding the Republic, which it may be of interest to reproduce.

Situated in the heart of the South American continent, what may be called Paraguay proper, lying between two big rivers, Paraguay and Alto Paraná, has an area of approximately 61,600 square miles and a population of some 800,000. The official language is Spanish.

The country is divided by nature into two fairly well-defined zones: the eastern half, for the most part rolling and hilly, is practically one immense forest; the western half consists of grassy plains with occasional forest-covered hills drained by numerous streams flowing into the river Paraguay, which are invariably heavily wooded. The soil in the forest clearings, in which all agriculture is carried on, is amazingly fertile, whilst the plains are eminently adapted to stock-breeding and fattening. The forests of Paraguay produce not only many kinds of hard and valuable woods, but the green tea known as yerba which is prepared from the leaves of the *Ilex Paraguayensis*, a tree that grows in immense numbers in the east and north-east. Apart from agriculture, which is rapidly developing, stock-breeding, timber, and yerba are, consequently, the three most important native industries. Natural waterways, navigable for shallow-draught barges of 50 to 100 tons capacity, abound throughout the country.

The principal towns are Asuncion, the capital (founded in 1537), 70,000; Villarrica, 10,000; Concepcion, 8,000; Encarnacion, 5,000; Pilar, 5,000. (Figures estimated.)

The principal ports are Asuncion, Concepcion and Pilar on the river Paraguay, and Encarnacion on the river Alto Paraná.

The only public railway in the country is the Paraguay Central (4 feet 8½ inch gauge) from Asuncion to Encarnacion—232 miles—where there is connection by train ferry with the Argentine system extending to Buenos Aires. There is also a branch of this line, about 30 miles long, running eastwards from a point near Villarrica, which serves for the extraction of timber from the forests in that neighbourhood. Of private industrial lines, 2 feet 6 inch and 1 metre gauge, three or four are in operation, their aggregate length being about 80 miles; and there is a steam tram between Asuncion and San Lorenzo (12 miles) operated in conjunction with the electric tramway system in the capital.

In addition to Paraguay proper, as described above, there is the Chaco Territory on the western side of the river Paraguay, over which Paraguay has always exercised jurisdiction, but which, nevertheless, is claimed by Bolivia as part of that Republic. The area of this disputed territory is in the neighbourhood of 100,000 square miles, and practically all of it was sold many years ago by the Paraguayan Government to private individuals and companies, mainly foreign, by whom it is now held under Paraguayan title. Very important petroliferous deposits are stated to exist in many parts, particularly in the west and south-west. The greater part of the territory, however, is still occupied by nomadic Indians of various tribes and dialects, numbering, it is estimated, between 10,000 and 20,000. The only industries carried on therein at the present time are stock-breeding and the manufacture of quebracho extract, or tannin, both of which are of some importance. Some 200 miles of light railway, in the aggregate, are employed by the various tannin factories to bring the quebracho logs from the forests to the mills which are situated on the River Paraguay, and it is estimated that this industry provides employment for a floating population of some 10,000. Immense forests of hard wood, vast open plains covered with somewhat coarse grasses, interminable palm groves and swamps, are the chief characteristics of this still wild district. The entire territory is quite flat and is liable to inundations over enormous expanses by the river Paraguay and tributary streams.

The climate of Paraguay may be considered good and suitable for Europeans, although possibly somewhat relaxing. The average temperature is about 75 deg. Fahr. In the winter months (June and July) there are occasional frosts, and in summer the glass not infrequently reaches 100 deg. in the shade.

PRODUCTION OF "RAYON" IN GERMANY.

The production of artificial silk ("rayon"), especially the viscose product, has increased considerably in Germany during the last few years. Estimates of the output of rayon in 1925 range from 26,000,000 pounds to 33,000,000, compared with approximately 23,600,000 in 1924 and 13,000,000 in 1923. According to reports furnished by the United States Vice-Consul and the United States Assistant Trade Commissioner at Berlin, between 60 and 70 per cent. of the total German production of rayon is credited to the Vereinigte Glanzstoff-Fabriken of Elberfeld, a corporation having plants in Oberbruch, Sydowsaue, Kelsterbach (near Frankfort

on the Main), and Obernburg on the Main in Bavaria. This concern uses the viscose process. It has recently combined with a well-known British concern for the erection of a new unit in Cologne with a daily capacity of 17,500 to 22,000 pounds of viscose rayon. The plant will employ approximately 4,000 workmen. The Glanzstoff company apparently anticipates greater domestic consumption rather than expansion of its sales in the markets of the world, and intends to increase its capital stock by 12,000,000 marks, to 42,000,000. This additional capital is to be used for technical extensions and improvements and also for the development of new manufacturing processes.

The I.P. Bemberg Co. of Barmen uses the cupra-ammonium process. Experts generally concede that Bemberg yarn possesses particularly attractive qualities which make it especially suitable for certain textures, but its use is limited inasmuch as its price exceeds that of the viscose product. Although the Bemberg works are closely connected with the Vereinigte Glanzstoff-Fabriken, they will continue for a time at least to use the old process owing to the popularity of Bemberg yarns.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JUNE 7..Actuaries, Institute of, Staple Inn Hall, Holborn, W.C. 5 p.m. Annual General Meeting.

Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Business Meeting.

Physics, Institute of, Royal College of Science, South Kensington, S.W. 5.30 p.m. Mr. H. E. Wimperis, "The Relationship of Physics to Aeronautical Research."

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

University of London, at the London School of Economics Aldwych, W.C. 5 p.m. Prof. C. Gini, "Some features of Italian Economics and Statistics." (In English) (Lecture I).

TUESDAY, JUNE 8..Anthropological Institute, at the London School of Economics, Houghton Street, Aldwych, W.C. 8.30 p.m. Mr. Michael Terry, "Some little studied Aborigines encountered during Travels in Northern Australia.

"Bribery and its Prevention, International Congress on, at the Royal Society of Arts, Adelphi, W.C. 10 a.m. to 5 p.m.

Colonial Institute, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Brig.-General Sir Percy Sykes, "Chinese Turkestan and the Pamirs."

Quekett Microscopical Club, 11, Chandos Street, Cavendish Square, W. 7.30 p.m. Messrs. E. Heron Allen and A. Earland, "Selective Building in the Shells of the Foraminifera."

University of London, at King's College, Strand, W.C. 4.30 p.m. Dr. J. W. Pickering, "The Constituents and Coagulation of Blood Plasma." (Lecture III).

WEDNESDAY, JUNE 9.."Bribery and its Prevention," International Congress on, at the Royal Society of Arts, Adelphi, W.C. 10 a.m. to 12.30 p.m.

Geological Society, Burlington House, W. 5.30 p.m.

Philosophical Studies, British Institute of, at King's College, Strand, W.C. Prof. S. Radhakrishnan, "The Philosophic Basis of Hinduism." (Lecture I).

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. Barcroft, "Lungs."

University of London, at the London School of Economics, Aldwych, W.C. 5 p.m. Prof. C. Gini, "Some features of Italian Economics and Statistics." (In English). (Lecture II).

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. A. J. Toynbee, "The International History of the Modern Islamic World." (Lecture II).

THURSDAY, JUNE 10..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Historical Society, 22, Russell Square, W.C. 5 p.m. Alexander Prize Essay.

Linnean Society, Burlington House, W. 5 p.m.

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. Newton Friend, "Science in Antiquity."

Royal Society, Burlington House, W. 4.30 p.m.

FRIDAY, JUNE 11..Astronomical Society, Burlington House, W. 5 p.m.

Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m. 1. Mr. J. H. Awbery and Dr. Ezer Griffiths, "The Latent Heat of Fusion of Some Metals." 2. Mr. D. W. Dye. "The Piezo-Electric Quartz Resonator and its Equivalent Electric Circuit." 3. Mr. E. J. Evans, "The Characteristics of Electrostatic Machines on Non-inductive Loads and on the Coolidge Tube."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. Dr. J. C. McLennan, "The Spectrum of the Aurora."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. J. A. K. Thomson, "The Development of Irony." (Lecture IV).

At the London School of Economics, Aldwych, W.C. 5 p.m. Prof. C. Gini, "Some features of Italian Economics and Statistics." (In English). (Lecture III).

SATURDAY, JUNE 12..Royal Institution, 21 Albemarle Street, W. 3 p.m.

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NOTICES.

COUNCIL.

A meeting of the Council was held on Monday, May 31st. Present:—Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Sir John H. Biles, K.C.I.E., LL.D., D.Sc.; Sir Archibald Denny, Bt., LL.D.; Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Sir Edward A. Gait, K.C.S.I., C.I.E.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, D.S.O., R.E.; Sir Charles C. McLeod, Bt.; Sir Philip Magnus, Bt.; Hon. Sir Charles A. Parsons, K.C.B., LL.D., D.Sc., F.R.S.; Sir George Sutton, Bt.; Mr. Alan A. Campbell Swinton, F.R.S; Mr. Carmichael Thomas; Professor J. M. Thomson, F.R.S.; and Dr. J. Augustus Voelcker, M.A., Ph.D., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant-Secretary).

Messrs. Bristows, Cooke and Carpmael were appointed Honorary Solicitors to the Society.

Names of candidates for the Albert Medal were selected for submission to H.R.H. the President.

Preparation of the balloting list for the new Council was begun.

It was reported that the number of entries for the May Examinations was 47,594, as compared with 46,778 in 1925—an increase of 816.

It was also reported that the number of entries for the Competition of Industrial Designs was 926 as compared with 813 in 1925—an increase of 113, in spite of the fact that an entrance fee has been charged for the first time this year in order to contribute towards the cost of the Exhibition.

Papers and courses of lectures for the session 1926-27 were considered.

Other formal and financial business was considered.

PROCEEDINGS OF THE SOCIETY.

SPECIAL MEETING.

THURSDAY, MAY 6TH, 1926.

SIR. CHARLES CHEERS WAKEFIELD, BT., C.B.E., in the Chair.

THE CHAIRMAN, in opening the meeting, said he hoped it might be taken as a thing of good omen that they had been able that afternoon to gather together to listen to what promised to be a most fascinating lecture. He was a hopeful person, and he did not share the dark view of things taken by some of his acquintances, but he must confess that he turned with some relief from the general strike to the discussion that Sir Frank Baines was about to unfold to them. It would be pleasant for a while to consider our irreplaceable heritage of beautiful old cottages in villages and hamlets up and down the country. Those fragments of stone, flint, plaster and wood had endured through many great national disturbances in the course of the centuries. However black the outlook had seemed to some of those who lived their lives in those ancient dwellings, we knew to-day that there had been an almost incredible progressive improvement in the social life of the people during those centuries. There was history in sticks and stones, and we did well to consider to what extent we could ensure that there was passed on to the next generation as much as possible of our architectural inheritance. Especially was that desirable in the case of the village cottages that spoke even more eloquently than did great historic castles and abbeys of the life of the people themselves, the shepherds and the tillers of the soil. They were things of beauty in themselves, and they afforded valuable first-hand evidence of the wonderful skill and craftsmanship of bygone days. The relentless pressure of present-day conditions would certainly mean the rapid disappearance of many of the picturesque old cottages that at present formed the architectural gems of the country-side. Unhappily, many once beautiful villages had already been despoiled by the erection of unsuitable and ugly villas and cottages, and the audience would hear with interest Sir Frank Baines' comments and suggestions in regard to what was admittedly a very difficult problem.

The following paper was then read :—

THE PRESERVATION OF ANCIENT COTTAGES.

By SIR FRANK BAINES, C.V.O., C.B.E., F.R.I.B.A.,

Director of Works, H.M. Office of Works.

The purpose of this paper is two-fold—practical and æsthetic; practical, in the sense that a cottage preserved is a cottage provided; æsthetic, for reasons which need not be emphasised to an audience such as I have the honour of addressing.

Cottage architecture is part of that great tradition of craftsmanship which distinguished mediæval England, part of that splendid practice of architecture which has been said to comprise the vast scroll of humanity, and has acted as the chief expression of man in all his stages of development.

In mediæval cottage building, the tradition is a peculiarly intimate one. Almost every tradition is contained within some building or monument. But cottage building, developing as it did side by side with human thought and capacity, and growing with the changing social conditions of the people, presents a changing yet true symbolism, transforming into palpable shape the records and history of the past.

That rural architecture which truly belongs to the village or hamlet is the building art of the village craftsman, and is a definite branch of our country's culture. In the chartered towns during the Middle Ages the powerful craft guilds held complete sway over their members, supplying the great ecclesiastical establishments and feudal lords with craftsmen of the highest skill, yet leaving at the same time a sufficient quantity and quality of craftsmanship for the intimate village building of which I speak.

The mediæval villages were small, containing from 50 to 300 souls. There was no primary difference between the municipal and the rural population. Some townships bought their freedom by charter earlier than others; some lingered unfree because their lords would not sell.

The men who built and lived in these villages did not "wade through slaughter to a throne"; in them were elements of a primitive yet orderly peace. We must not, however, disregard the elements of tragedy to be found in the village, witness the remarkable study of the conditions of mediæval peasant life made by Mr. G. G. Coulton.

No man who reads Chaucer's description of the Ploughman can doubt that at its best the life of the village had a true dignity. The poet urges us never "to forget the record of poor folk in cottages charged with children and with church lords' rent." It was families such as these which supplied our Universities with their best material.

Even in the Middle Ages a village aristocracy, not of rank but of merit, sprang up. When the villager bought his freedom he sought learning. His qualities came from the land which is eternally healthy, and like all people he suffered least when he was the least estranged from it; for nothing ultimately useful is to be obtained from this world of reality but what is wrung from it by the sweat of the brow.

To get a clear view of the conditions we must remember that 14th Century London had a population of only 30,000 to 40,000. This figure is proportionately far higher in comparison with the population of the leading provincial towns in the Middle Ages than obtains to-day. Lincoln, for instance, with a population of 5,000 was quite a small place in the 14th century. Domesday Book mentions 9,250 villages, 80 towns (or large villages) and 10 fortified towns, such as York, Chester, etc.; all with a total population of 2,000,000, 75% of which was engaged in agriculture.

In Chaucer's day it is said that at least 75% of the population consisted of peasants and 50% of the men were unfree. Yet there must have been a sense

of well-being in the country, for Chaucer's poetry breathes a freshness and vigour which reflects the healthy condition of Chaucer's England.

The English villager was probably better off from about 1450 to 1500 than in the earlier Middle Ages, and possibly than in the 17th and 18th Centuries. He enjoyed specific rights, as is shewn by the fact that certain villagers complained to their Prior that owing to his neglect they were losing their right of user which they had hitherto enjoyed in the manorial woods, from which they had been accustomed to take wood for fuel and building.

The cottage was recognised as being the chief material possession of the villager. When distresses levied upon him were not paid the Abbots had the right to remove his doors and windows. Priors are known to have claimed the right of seizing the door of any house the tenant of which refused to contribute to their mid-Lent bonfire.

The whole art of cottage building developed experimentally, as up to a certain point all forms of art must develop. Experience was intensified by the formation of certain practices into a kind of local tradition, which was handed on to the next generation under certain wide and general rules. Craftsmanship was not individual; it was superior to the individual. It existed as a great pool of experience and practice into which the individual could dip. His individuality was assisted and refreshed by reference to this common source of building knowledge.

The great cottage builder of the mediæval period was the carpenter, and the greater portion of both large and small houses was the work of the carpenter.

To get a clear view of the English cottage in the 13th century we can refer to a specification for a peasant's cottage in 1281. "There is to be built," runs the order, "a competent dwelling for her (a widow) to inhabit, containing 30 feet in length within the walls and 14 feet in width, with corner posts and three new and competent doors and two windows." This description points to a two roomed cottage, i.e., a living-room, which would be the widow's "hall and bower," and a stable, with a communicating door between the two. Chaucer clearly implies that his poor widow and her daughter lived on intimate terms with their livestock, while there is evidence that the early cottage type could readily be dismantled and removed. It is stated, for example, that about 1426 A.D. "William Found had departed and carried off his cottage."

With regard to rent, this was generally commuted in the interest of the lord of the manor, and in early mediæval times against the tenants' will. In the long run, however, it must have benefited the tenant through depreciation in money values. England was ahead of other European countries in the progress from the natural towards a money rental, for commutation had gone some way before the intervention of the Black Death. That appalling catastrophe shook what was already tottering in mediæval social life and was followed by a rapid increase in commutation. This is shown by the remarkable increase of free labour within 30 years of the pestilence. The hundred years which

followed the Black Death saw the complete disintegration of the old manorial order. Labour became scarce; it was impossible to enforce statutes on labourers or to prevent villeins from fleeing to townships where workers were needed. Thus a new class of yeomen grew up who had direct influence upon the tradition of house-building in England.

Before 1500 great cleavage was beginning between Capital and Labour. The breaking up of the village began long before the practice of Monastic enclosure had become so common as to call for interference. In 1414, near Cambridge, enclosure had reached such a pitch that most of the labourers were turned off the land, and " there was great waste of housing and of hallies and chambers, and other chambers of office and common housing left standing thereon." It was left to a commission under Wolsey in 1517 to grapple fearlessly with the enclosures, but the loss in mediæval cottage building must have been immense. The Abbots appear to have been great offenders by enclosure, and in More's " Utopia " it says, " they threw down houses, they plucked down towns and leave nothing standing but only the church to make a sheep-fold." The monk appears to have been a capitalist first and a churchman afterwards; and if England had no Goldsmith in 1500 it had its " deserted village."

The early mediæval serf though distinctly above the slave was no less distinctly below the free man. The Black Death helped him to break down his ancient disabilities, and there thus sprang up a class of yeomen in the villages whose dwellings survive in part to-day. These dwellings it is our duty to preserve, for without the material for comparing the status of human life and the facts of social conditions at different periods and in different places, history can teach us little. The record afforded by the surviving cottage architecture is of vital historic importance.

After the Black Death, when the shortage of craftsmen gave bargaining power, the conditions of Labour were still far from ideal. Gower was apparently scandalised by the wages which labourers asked, and shows a simple horror that the shepherd and cowherd should demand wages higher than the master bailiff was wont to take. The ideal labourer was still held to be one who was content to dine on yesterday's cabbage, with penny ale and occasionally a piece of singed bacon.

To illustrate the villagers' rate of payment, dairymaids could be hired at much less cost than men, although the dairyman, cheapest of all farm servants, received only 5s. a year to the bailiff's 13s. 4d., the ploughman's 10s. and the carter's 6s. 8d. 5s. then was equal roughly to £5 in pre-War days. Plain board and lodging was included but feeding was of a poor order. On Fridays and fast days a farthing's worth of mussels was considered a feast " for such folk."

As to their hours of work we learn from Beverley Town documents that the work of the craftsman in the 15th century began at 4 a.m. from Easter to August and continued till 7 p.m. At 6 a.m. a quarter of an hour was allowed for

drinking, at 8 a.m. half an hour for breakfast, at 11 a.m. an hour for drinking. After August 15th work lasted as long as the light, with half an hour for breakfast at 9 a.m., an hour for dinner at 12 noon and a quarter of an hour for drinking at 3 p.m.

The statute of 1562 relating to artificers fixed the minimum working day between the middle of March and the middle of September at 12 hours, and the term of apprenticeship at seven years. The craft guilds themselves had very definite rules, and in the chartered towns they held complete sway. In the smaller villages there was often a guild for craftsmen of all the combined trades. Travelling bodies of craftsmen appear to have moved over the country, while if any craftsman wished to follow his craft unrestricted he could elect to work beyond the confines of a town, and probably he was instrumental in evolving the traditional village craft of many districts.

There is ample evidence, however, to show that much of the village building was done by trained craftsmen outside the great guilds. For instance, John Cross, the village carpenter of Yatton, Somerset, made a rood screen for the parish church, which was executed for a sum of £3 10s. 4d. in 1447. John Wright of South Mimms, a small village even to-day, carved the beautiful corbels supporting the wall posts of Henry VIII's Great Hall at Hampton Court, in 1532.

Village architecture brings down to our own day the true traditional work which began to be lost as a result of the Renaissance. Yet there were exceptional cases, where great lords such as Wolsey remained the patrons of native English craftsmen. Between 1515 and 1529 Wolsey engaged at Hampton Court Palace craftsmen whose names are uniformly English. Of those engaged between 1689 and 1723 only one was English. The fifteenth century buildings of Norfolk are entirely English, as also are those of Somerset, but in spite of this their location can be perceived at a glance by those with knowledge of the distinctive local tradition.

If England is not to suffer from the criticism addressed to the United States by Henry James that "they lacked all sense of the past," attention must immediately be directed to the preservation of the ancient cottages still remaining in this country. The subject is becoming a vital one to those who have this "sense of the past." The vice-Chancellor of Oxford recently called attention to the matter, and after emphasising the fact that our villages and many of our country towns still preserve the beauty of the past, pleaded for immediate action for their continued preservation.

Mr. Henry Batsford, to whom I am indebted for many of my slides, has also concerned himself very earnestly with this question. Lamenting the enormous loss of traditional architecture within the last century he instances the wonderful collection of drawings by John Buckler, about 1830, showing the quality of the smaller Hertfordshire townships, once beautiful with gabled buildings, but now universally commonplace or even slummy. Even 100 years ago the amount of beautiful domestic architecture was amazing, and before

the 19th century laid its blighting hand upon them, cities such as Bristol and Exeter were indeed exemplars of architectural excellence.

The subject would seem to make an almost universal appeal. The veriest philistine will agree that preservation is called for. Up to the present, however, little has been done, except that attention has been called to the problem by societies such as the Society for the Protection of Ancient Buildings and the National Trust, and by individuals such as Mr. Sidney Jones, the late Mr. Galsworthy Davie and Mr. Avray Tipping. To mention all those who have done excellent work would take up more time than I have at my disposal; but the time has now arrived to put the issue on a broad national basis so that the bitter loss going on from day to day may be ended once for all.

The President of the Royal Institute of British Architects recently emphasised the need for the preservation of cottages, not for their antiquity merely, but for their utilisation as repaired and hygienic houses, retaining their ancient charm and linking with the interests of to-day the associations and traditions of the past.

The question is often asked as to whether the Commissioners of H.M. Works and Public Buildings can take over and preserve cottage architecture, and whether they can definitely act to prevent the destruction of such buildings. As matters stand the Commissioners are precluded from safeguarding buildings used as dwelling houses under Section 8 of the Ancient Monuments Act of 1913.

Taking a broad view of England we observe a large central band of oolitic limestone running from Portland and the Severn in a north-easterly direction to the Humber and the Tees. This great deposit supplied excellent building stone to the Cotswold and Northamptonshire craftsmen. In the south-east and in the West Midlands was abundant timber, while in most parts of the country clay was plentiful. In the south-west there was granite, a difficult and intractable material whose use evolved an admirable if severe local type. In the north were various hard stones and in the chalk districts there grew up a traditional use of flint for house-building, which in East Anglia showed a remarkable craftsmanship in the use of this refractory material.

To-day there is a consistent extinction of local tradition in the village and countryside. Of all the housing erected within recent years the great majority is stamped with a sameness of type, proclaiming it a growth from one movement. The menace to-day is a growing one and is graver than it has ever been. There is the local builder who buys up old property and "improves" it. There is the loss incurred by the movement into our villages and townships of the banking and public house interest, involving, with its passion for "desirable corner sites," the demolition of fine original work. There is the danger to cottage buildings through the provision of new and widened roads for motor traffic. There is the further risk arising from sheer indifference, ignorance, incompetence and absence of financial resources; and, finally, there are the great losses through fire.

I do not propose to attempt in this paper to give a schedule of examples of destruction, neglect and ignorant spoliation; they are legion. They depress the mind rather than assist it to take action. Our problem to-day is to interest those who are prepared to assist in and devise a scheme which will prevent this waste and destruction in the future, without alienating the cottage from its original purpose, preserving it as a definite contribution to the housing problem of the people.

An ignorant lack of appreciation has been the cause of the loss of much beautiful old work. In certain cases this is due to an entirely wanton destruction: witness one most lamentable instance, that of a house in

FIG. 1.—Demolished Cottage at Craven Arms, Salop. (Reproduced from "Old Cottages, Farmhouses and other half-timber Buildings in Shropshire, Herefordshire and Cheshire," by J. Parkinson and E. A. Ould. Published by B. T. Batsford, Ltd.)

Shropshire, at Craven Arms. It was a beautiful cottage, composed of half timber, and plaster, with tile and stone-slabbed roof; it had some remarkable brick chimneys—a wonderful piece of complete design, which can never be recaptured for England.

Again, a most beautiful cottage of half timber, tiles and thatch, was demolished at Storrington, on the South Downs; and another perfect example of the usual 17th century Cotswold type at Box, Wiltshire, with

stone walling and stone slates. All these have been demolished in comparatively recent years.

At Stourbridge, Worcestershire, a piece of village composition, perfect in its way, a complete row of cottages, was demolished to make way for a public library and a war memorial in the worst of taste.

At Birchington, Kent, a very simple type of brick and tile cottage, quite distinctive of its kind, was pulled down in 1916; while the Press announced recently a proposal to demolish the First and Last Inn, Exmouth—one of the oldest in the country—to make room for modern premises.

In other cases destruction has been due to perhaps uncontrollable causes such as tempest and fire. For example, cottages of cob walling and thatch at North Tawton, Devon; cottages of stone, brick, plaster and thatch at Mildenhall, Wiltshire. Another of timber frame, parge and thatch, a striking example of a cottage dated 1653, at Stanstead, near Long Melford, Suffolk.

FIG. 2.—Destroyed Cottage at Stanstead, Suffolk. (Reproduced from "Old Houses and Village Buildings in East Anglia," by Basil Oliver. Published by B. T. Batsford, Ltd.)

Many cottages are in the last stages of dilapidation, such as those at Wyrardisbury and Brill, Bucks., built of half timber, plaster and tiles; and at Castle Combe, Wiltshire, is one likely to be lost for ever. Others at Nunney, Somerset, built of stone and stone slates in the finest tradition, are also in the last stage of decay. These cottages are probably of late sixteenth century date, and share the neglect of the fine Castle in the village.

FIG. 3.—Derelict Almshouses at Nunney, Somerset.

Others at Cleobury Mortimer, Shropshire, of half timber and stone slates, at Normandy Village, Surrey, of half timber and tiles, are in the last stages of dilapidation; while "restoration" has robbed the cottages at Hitchin, Hertfordshire; Shanklin, Isle of Wight; Beddington, Surrey; and Ombersley, Worcestershire, of all their original quality.

Innumerable examples can be cited of the introduction of modern and foreign material, substituted for the native material of the district. At Musbury, Devon, for example, corrugated iron has been used over the old thatch. The list could be indefinitely extended—a catalogue of callousness and error.

The need to be up and stirring is only too plain. The repeated and determined efforts to sweep away Archbishop Whitgift's Hospital at Croydon are too well known to need emphasis; and the proposal to destroy that fine group of cottages at Bury St. Edmunds, with the "Star" Inn, as the centre, with

its remarkable chimneys, is another instance. In this town a row of charming cottages has already been swept away.

I propose to show a group of slides, bringing out that quality in the cottage buildings of this country which appeals to us all without distinction.

The majority of ancient cottages remaining to us date from 1580 to 1690. Earlier examples of course exist, as at Montacute, Somerset, a Tudor cottage of coarse rubble, with freestone dressings, where, unfortunately, the roof has been lowered; and the importance played by roof style is well brought out by the view of the village of Corfe Castle, in Dorset; and the roofs of cottages at Bradford-on-Avon, in Wiltshire. In the last view the stone slates in their diminishing courses, with swept valleys and stone verges, are seen from above; we have no roof of anything approaching this quality in our latter-day cottage building. A good deal of work in this style still remains, more particularly in Gloucestershire, although Mr. Guy Dawber has pointed out how, during the eighteenth century and later, it was no uncommon occurrence for the cottagers to be turned out of their villages, and their dilapidated cottages pulled down to remove a burden from the landowner. This is held to account to some extent for the lack of cottage building between the end of the seventeenth century and the middle of the nineteenth.

The example from Bibury, in Gloucestershire, is of a more or less normal type, but variations from this are considerable even in the same county.

Church Iccomb, Gloucestershire, shows straight-headed half dormers, with eaves; and at Coln St. Aldwyn, Gloucestershire, we see one-storey cottages, with typical dormers in the roof.

Again, at Weston-sub-edge, these delightful cottages show stone verges to the dormers.

The Westington cottage at Campden, Gloucestershire, has a typical thatched roofing, giving a very distinctive character to the dormers.

The bay in the gable at Lyddington, Rutland, is reminiscent of the earlier work at Montacute in Somerset, and at Finstock, in Oxfordshire, the steeply pitched thatched roof belongs to a type found more normally in Northamptonshire.

In some parts of Somerset, lias takes the place of freestone for all the dressings, and in Northamptonshire ironstone quoins and bands of a rich brown colour are common, as at Blisworth and at Yarwell. In the same county we may see that successful feature, the canted bay with square top on plan, which occurs at Duddington, and elsewhere. The remarkable architectural quality of these cottages is well shown in the view; at Colley Weston we get a good example of a Northamptonshire village of the Cotswold type. If you stand by Broadway Tower on the steep northern escarpment of the Cotswolds and look over the "coloured counties" behind you, all the villages are built of limestone, and Broadway is the last outpost of the Cotswold type.

On either side of the great oolite belt, up to a line drawn roughly between the Dee and the Wash, to the marshes of Wales in a North-Westerly direction, and to the English Channel and almost to the North Sea, if we exclude part of Wiltshire and also Norfolk—the most normal type of cottage is of timber-frame construction. Although the North-Western types vary materially from those in the South-East, yet, as in the churches we find a striking resemblance between Tichmarsh Tower in Northamptonshire and those of Somerset, so, in the cottages also we find at Middlebrook, Herefordshire, a type which would be just as much at home with the traditional work of the South-Eastern counties. Here the projecting windows have unfortunately disappeared, but the distinctive type still shows from what is left. The greater number of the timber-framed cottages in this country were built during the latter half of the 16th to the first quarter of the 17th centuries, the last fifty years of which were the most productive. In the North-West counties the timbers were larger and more massive than in the South-East, and the overhangs are consequently bolder. Moreover, the elaboration of ornamental forms in the timber itself becomes more apparent, particularly so in Cheshire. Flags and slates of a far heavier variety than are found in the limestone district or Cotswold type, are used as roof covering, as an alternative to thatch. Plain tiles become common, although Mr. Ould suggests that these are not original, as tiles are believed to have been little used when such cottages were built, owing to the difficulty of burning them. For a similar reason, bricks were only used where no stone was available. Chimneys are usually of stone, but to-day the shafts have often been rebuilt in brick, and those on the ridge are also of brick. The suitability of the flagged roofs to the heavy type of timber frame is well shown from the example of Eardisley, Herefordshire. Generally, the colour scheme of such cottages is black and white—hence the name "magpie." Occasionally other surface colour is used for the infilling between the timbers, as at Orleton cottages. Here an orange buff colour is employed. This cottage is thatched, but the adjoining shed is flagged, and has been patched with tiles, resulting, however, in a colour effect entirely satisfactory.

A delightful idea of the general appearance of a Herefordshire village is given in the view of Cradley, lying below the western slope of the Malvern Hills. No composition could be more perfect. Such views give us, as Pater said, an indescribable sense of well-being, breathing a welcome and the very spirit of home.

Interesting Herefordshire examples also occur at Pembridge and at Weobley. The sad plight of Weobley can probably be accounted for by the fact that the village was a decaying one, containing quite a collection of timber houses. They were mostly owned by their occupants, who could not afford to keep them in repair. Weobley once returned two members to Parliament, and it is recorded that previous to the Reform Bill the Marquess

of Bath, who owned the whole place, allowed the tenants to live rent-free as the price of their vote to his nominee. If this is true, Weobley, when it lost its representation, lost the reason for the landlord foregoing his rents. Even so, he could not collect them, the inhabitants having lived rent-free for so long; but the tragedy, which has a distinct social significance, is that the houses had fallen into such a state of disrepair as to be scarcely habitable; then the cottage owners began to miss the presence of the landlord and his agent, who normally would have kept them in reasonable repair. The cottages known as "The Rows," previously mentioned, belong to the fifteenth century, but were rather spoilt in the middle of the last century; although the effect of thatch and plain tiles can be well seen from Bromfield and Worfield respectively, both Shropshire examples.

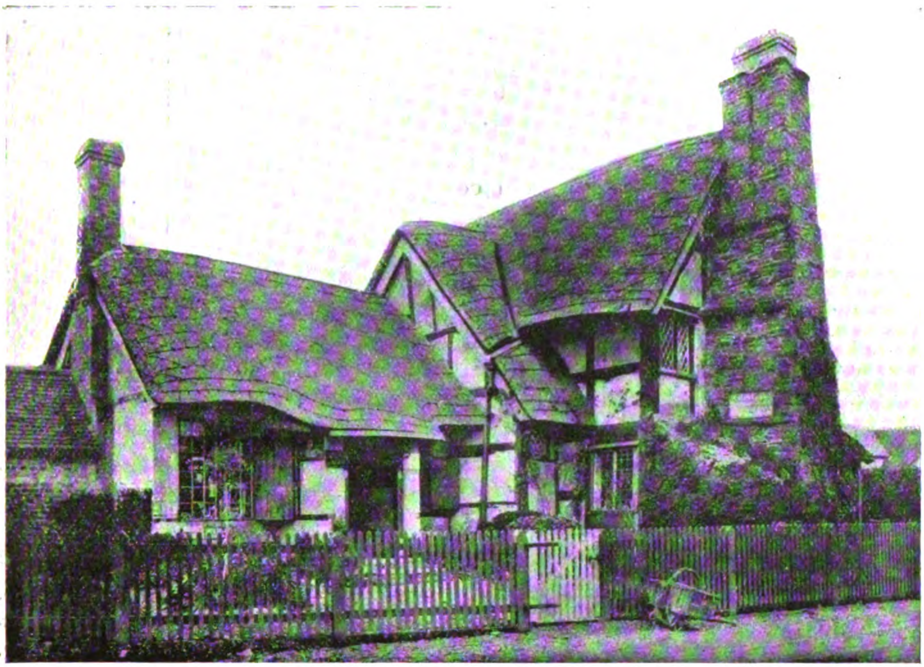

FIG. 4.—Half-timber and Thatched Cottage at Bromfield, Salop. (Reproduced from "Old Cottages, Farmhouses and other half-timber Buildings in Shropshire, Herefordshire and Cheshire," by J. Parkinson and E. A. Ould. Published by B. T. Batsford, Ltd.)

At Alderley Edge, in Cheshire, is a magnificent example of the more elaborate type—a piece of work beautiful in composition and delightful in proportion. Again, at Alderley Edge is another type of the more simple timber-frame construction; both are typical of the North-Western style prevailing to-day in many examples of traditional half timber work.

FIG. 5.—Cottage Gable at Alderley Edge, Cheshire. (Reproduced from "Old Cottages, Farmhouses and other half-timber Buildings in Shropshire, Herefordshire and Cheshire," by J. Parkinson and E. A. Ould. Published by B. T. Batsford, Ltd.)

Turning to the counties South-East of the oolite belt, although it would be fair to say that the prevailing type of cottage construction is of timber frame, yet there are interesting exceptions which should be glanced at before referring to the true normal type. These were produced probably as a result of the large amount of flint found in the chalk which runs parallel with the oolite belt, and which also occurs in comparatively narrow belts from Hampshire to the East coast of Kent and on the Sussex coast surrounding Beachy Head. In Norfolk and in the North-West corner of Suffolk, we get a distinctive traditional use of flint and brick in cottage building. The cottages have steep roofs and are covered with pan-tiles, either glazed or unglazed, of a brownish-black colour, or are thatched with straw and reed. The gables are shaped or crow-stepped, and ornamental wrought iron wall ties are used, frequently in the form of initials and dates on the surface of the walling.

At Trunch is a good example of a very simple flint and brick, reed-thatched

cottage, with decorative chimneys; while at Wiggenhall St. Germans, Norfolk, is a remarkably interesting type with stepped gables and a steep pan-tile covered roof, obviously showing the influence of the low countries. In the most eastern parts of Kent, a similar type of building prevails, showing a very distinctive tradition, with influences not entirely local or national.

In the South of Wiltshire, cottages are constructed with walls of a mixture of flint, brick and lumps of stone. Others have an infilling between timbers of alternative layers of flint and brick. Again, we find walls built with a filling of flint and hard chalk, a type found in Surrey and other parts of a like geological formation. Flint again is used to a very considerable extent in the cottages of the Chilterns, with a patterning introduced, giving distinctive features to the traditional style. In the Northern and Western parts of East Anglia cottages were sometimes built of "clay-lump," and for the full thicknesses of walls. Often the clay-lump has been faced in modern times, and in isolated districts of Surrey and Kent stone was sometimes used.

If we revert to the more normal timber-framed cottage construction, we find that in East Anglia the spaces between the timbers are frequently filled with a mixture of clay and chopped straw, reinforced with hazel sticks, or clay is squeezed between hazel sticks and surface plastered. It is sometimes contended that very little brick-nogging was originally used. Certainly, authentic examples of the treatment appear to exist, but it is considered to be generally a later treatment. Tile-hanging from a wall surface is practically unknown north of Chelmsford. This is also true of weather-boarding, so far as cottages are concerned, although riverside mills are frequently weather-boarded in a number of counties, where the traditional method of building is shown to be quite otherwise. In Suffolk, and more particularly in Essex, timber-frame construction has often been protected by "pargetting" at a later period as a protection from the weather. The parge consisted of a mixture of lime, sand, cow-dung, road-sweepings and hair, and is often applied in a most ornamental manner.

The example of the cottage at Clare, Suffolk, is a good one, as here we can fix its date somewhere about 1473, although the parge itself belongs to the seventeenth century.

At Kersey, near Hadleigh, Suffolk, are some delightful cottages typical of this district. They were probably built for Flemish and Dutch weavers, and may have served originally for more important purposes. They belong to the late sixteenth century, and the spaces between the upper windows (which would appear to have been altered) and those on the ground floor of the bays are parged. It will be noticed that in the gables or dormers is some curiously worked coloured, lozenged patterning. The whole village of Kersey is quite sufficiently beautiful to be a show-place of England. In some ways this is a protection; it is less open to spoliation, but it may be seriously affected by the proposals of well-wishers who are uninstructed in the method of preserving such a priceless heritage.

At Margaretting, in Essex, a great loss has been suffered from alterations of the original cottages. The view of the cottages and a shop illustrates the alterations that have occurred, and the heaviness of the loss.

At Cockfield, Suffolk, is a beautiful specimen of a half-timbered composition with diagonal brick-nogging, perfectly simple in design, with its clustered flues and undulating roof—a peculiarly satisfactory type.

At Cavendish and Worlingworth are examples of group timber-framed cottage buildings, with plaster and thatch, where the whole principle of village planning is well brought out.

In Essex, at Little Dunmow, we see a group of half timber and plaster thatched cottages, partially weather-boarded, which is an unusual feature in East Anglia. Here is an example of the most delightful groups of cottages which can be seen. The great area of roof, and the advanced gables, combine to form a model of architecture for housing the people.

At Gosfield, near Halstead, is another example of the timber-framed construction, partially exposed, with a beautiful ornate and elaborate chimney.

Although weather-boarding is scarce in the case of cottages, it is often used for other buildings, an example of this being the windmill adjacent to a group of cottages at Finchinfield, Essex.

There is the special problem, not only of the preservation of the individual cottage or group of cottages, but of the complete small hamlet and township. Here group effect is all important; the complete picture is even of more consequence than the individual fragment. In certain of our towns this group design is rapidly disappearing; witness the case of Edgware, where the character of the village has been entirely altered within recent years. Almost the only hope for our group village and township architecture is when it is out of the way from the main traffic stream, as in the case of St. Albans, Fishpool Street, where the total composition would be ruined by any alteration of any of its various parts.

To illustrate again the complete composition of a village we have the quite late example of Castle Street, Farnham, Surrey, where a number of cottages of eighteenth century date are almost as complete and perfect a picture as many of earlier composition.

In the case of Steyning, Sussex, we have as satisfying a composition of a village of an earlier date as we could demand.

We have a great responsibility towards these group cottages, while many a Georgian town and village calls for a complete control to preserve what is there as a whole, with due relation to the requirements of modern sanitation and hygiene.

If we turn our attention to the South of the Thames, to Surrey, Kent and Sussex, we find they are all generally timber-frame counties, bearing in mind the reservations already made. Formerly the Weald of Kent and Sussex was covered with thick indigenous woodland, but the surface iron smelting

industry gradually denuded it of forest, until there was actual shortage of heavy timber, as compared with the North-West Midlands, during the great cottage building period. This is reflected in the framework of the cottages, showing the interest of traditional building methods, where they illustrate the history of the district in which they are erected. In isolated stone districts, the roofs are sometimes covered with "Horsham slates." These are stone slabs, midway in size between the Cotswold and Shropshire types. There is an excellent example in the half-timbered cottage at Ewhurst, Surrey, with its diagonal brick-nogging and external stair. Latterly, plain tiles are the more usual covering, and frequently form an important feature in the design, as in the delightful half-timbered cottage at Frensham, in Surrey.

FIG. 6.—Front View of Cottages at Eashing, Surrey. (Reproduced from "Old Cottages and Farmhouses in Surrey," by W. G. Davie and W. Curtis Green. Published by B. T. Batsford, Ltd.)

From the charming group of cottages at Eashing, Surrey, we see that the traditional method of building produces as beautiful a design at the backs of the cottages as for their fronts. There are no "back additions" here, nor would it appear that any distinction was felt by the craftsman.

Weather boarding, often covering older buildings, is common in the villages to the South of London. Distinctive examples at our very door are at Cheam,

FIG. 7.—Back view of Cottages at Eashing, Surrey. (Reproduced from "Old Cottages and Farmhouses in Surrey," by W. G. Davie and W. Curtis Green. Published by B. T. Batsford, Ltd.)

Surrey; and at Hawkhurst, Kent, where partial weather boarding has been most successfully carried out, though obviously later than the date of the cottages themselves.

Vertical tile hanging is not so common, but a good example occurs on the hipped gable of a cottage at Goudhurst, Kent, and in a number of other places such as Tenterden, Kent, where the method adopted seems native to type.

At Fittleworth, Sussex, we have an example where the eaves project even over the oriel, and this is one of so large a number of lovely cottages that it is difficult to select sufficiently representative examples to show the nature of the appeal made to a knowledgeable sympathy and understanding which will preserve such distinctive work.

I give two examples from Kent, one at Swanton Street, and one at Horsmonden; the first of peculiarly fine quality, and the second in its simplicity of distinctive merit; at Byworth, Sussex, is an example much more modest in scale, thoroughly typical of this district.

FIG. 8.—Back of Half-timber Cottages at Swanton Street, Kent. (Reproduced from "Old Cottages and Farmhouses in Kent and Sussex," by W. G. Davie and E. G. Dawber. Published by B. T. Batsford, Ltd.)

At Hardham, Sussex, the one example given is a complete picture in itself. The steeply thatched roof, the small dormers, the association of half-timber with the window and door spaces, all show how rich this country is in work of the very highest standard; the type at West Burton, Sussex, is particularly simple and homely.

In the counties further West the timber-frame cottages are very similar to those I have reviewed. The old house on the Bath Road at Woolhampton, Berkshire, represents a traditional method of building, very similar to that of Kent and Sussex.

In the comparatively small county of Dorset are three distinctive styles such as we see at Corfe, Studland, and Blandford St. Mary.

In North Wiltshire we strike a rapid change from the traditional Cotswold style to timber-frame construction, and to the North of Salisbury Plain there are to-day scores of villages containing examples of the latter type which are for the most part heavily thatched, such as at Enford, and Marlborough, with its delightful street composition.

At Bottlesford and at Ogborne St. Andrew, we have two beautiful examples,

the former gaining if anything from the juxtaposition of the lamentable modern building behind it.

At Manningford Bruce and Rushall, Wiltshire, we have isolated and eminently typical examples, while at Pewsey is a happy composition of brick and plaster occurring in natural conjunction with thatch.

In portions of South Wiltshire and parts of Devon, where the geological formation is favourable, much of the cottage walling is built of "cob." This consists of chalk or loam, or whatever suitable earthy material is found on the site, mixed well with straw, firmly rammed into position, and cut to a vertical face with a spade. Often such "cob" walling is plastered on the external face. Again, rough stone, usually plastered, or lime-washed, is used in Devon, as at Uplyme, where an agreeably picturesque group can be seen.

In the extreme West practically all the cottages are built of granite or of slate. They are characteristic of the wildness of this wild coast, and when untouched by the modern builder's methods, fit in quietly with the multi-coloured granites and ironstone cliffs.

A beautiful example of a complete village street can be seen at Looe, but to the right of the view will be seen the intervention of the graceless modern building.

The cottages of St. Ives give a typical picture of a West Country street. Large external chimneys are often a feature, and the intractable nature of the material—granite—is overcome by the adequate and capable methods of the local stone-waller.

In Somerset, such great chimneys are often finished with circular shafts, giving a very distinctive character to the work of the district.

In the North, where unhappily so little really good traditional cottage work remains, severity is also the key-note as in the extreme West. Here the chimneys nestle to the roofs, the windows and doors are small, a tribute to the climate. In Lancashire the external staircase is occasionally met with and the cylindrical chimney. In Northumberland are ranges of old dwellings apparently of stone and brick with "tumbled in" brick gables of flat pitch, covered with stone slabs, a very typical method, which can be seen at Hexham.

At Bishop's Middleham, Durham, we see a row of cottages of stone and brick rough-cast covered with pan-tiles, again directly reflecting the extremity of climate, and yet presenting a sufficing and adequate design.

In the majority of old cottages still remaining up and down the country, the material comprising the shell is often equal, if not superior, to that employed in modern dwellings. Alteration may be called for, but repair would not be difficult. Only in extreme cases is the charge likely to be more than that for entirely new cottages. The purely technical and physical problem of repair can always be dealt with by an architect adequately equipped and with the requisite sympathy to devise means. In many cases the repair and

preservation is likely to prove reasonably economic; this has been well illustrated by a case described in "Country Life," in which Mr. Avray Tipping was interested.

Where the movement for preservation is directed and made effective, demolition would not be permitted. It might even be possible to attempt a re-creation of the original village craft spirit and method, whereby local craftsmen added to, patched and repaired with local materials the village cottages. Where, however, the decay has gone so far that neglect would appear to involve demolition, the cost of repair will be greater, and might indeed be held to be in excess of the value of the property. Merely economic values, however, have no true relation here; but the assistance of a strong, even national effort, is certainly called for.

Examples such as that shown of Nunney, Somerset, would involve heavy expenditure. They are well worth such expenditure, and it should be the object of any movement to see that their neglected condition does not involve their final loss. All that appears to be called for is a unification of every effort of those who are profoundly concerned with the distinctive possession of this country in its cottage architecture. Direction and financial assistance would seem to be the immediate need, and it is my privilege to be able to say that the Royal Society of Arts has undertaken to initiate and endeavour to organise a movement, directed towards the final preservation of the cottage architecture of this country. With the great traditions behind this Society, and its magnificent record of work accomplished, it should succeed where others have failed; it will, I feel sure, collect together a band of enthusiasts whose interest in the problem must produce outstanding results of vital and permanent benefit to our country.

The first essentials are sympathy and enthusiasm; knowledge and eager assistance; financial and otherwise. They are all available; they are waiting to be called into action; and the Council of this Society will call to a conference all those anxious to help, and devise a scheme to accomplish our aims.

I do not propose to attempt to outline specific proposals. The conference will be charged with that important function, and will be much more competent than I am to discharge it. My aim this evening is to lay bare the issue and to seek to gain your interest and support by a review—incomplete and imperfect—of the causes which produced English mediæval cottage architecture and a craftsmanship of eternal freshness and capacity; which, interacting by change with social conditions, is a vital part of our national past. Much of the charm and picturesque beauty of such cottages as we have seen and clearly perceive to-day, is sometimes held to be illusory; for when we grudge the loss of what is alleged to have been an ancient earthly paradise, we may be ignorantly reflecting upon conditions which were crying for amendment and alteration. This pessimistic view would find most things

illusory; yet it will be useful if only it prevents us regarding our subject merely sentimentally. Sentiment is said to be a fog about the feet of truth; but no one can deny the validity of true sentiment, and not only for æsthetic reasons, but for historic and sociological reasons, have we a right to demand an interest in these records of the society from which we spring. It is a national duty to preserve such records, beautiful in themselves, of a culture entirely our own, more especially when they are the authentic and full particulars of our ancient cottage building—a documentation which once destroyed can never be replaced.

There are certain elements of mediæval society which are only clearly brought out in mediæval building, and particularly are the elements of social history brought out by an understanding of the village; its preservation, therefore, is of vital importance, purely as historical fact. It is our scroll of tradition unrolled in "England's green and pleasant land"—a most perfect and orderly record, from which a clear historical synthesis can be obtained, giving a re-orientation in the study of the past, of the lives and social habits of our people; and it constitutes the vital material and spirit of our history.

That any appeal should, in fact, have to be made for the effective preservation of such a record implies an indifference which is a slur upon the national intelligence; for to lack any appreciation of the records of history is to have no past and to deserve no future.

DISCUSSION.

MR. A. R. POWYS (Secretary, Society for the Protection of Ancient Buildings) expressed his Society's very sincere appreciation of the work which the author had done in the matter of preserving the ancient cottages of the country. Hitherto there had been all sorts of difficulties, but now that the Royal Society of Arts was going to call a conference of all those who were interested in the matter, he felt there was real hope that something might be done to preserve these cottages throughout England, not only as a matter of sentiment—which was very important and must not be neglected—but also as a real contribution to the solving of the problem of the housing of the people in a way that was healthy and happy.

MR. R. GARRAWAY RICE (a Vice-President, Archæological Institute) said in many cases modern repairs had been carried out on ancient cottages which had added considerably to their picturesqueness. For instance, he thought the bulk of the feather-edge boarding seen on cottages at present had been placed there in more or less recent times, probably for the purpose of making the buildings weather-tight. He also knew of a modern cottage in Sussex which, if one had not known it had been recently built, one would have assumed was a 17th century cottage, which had had the feather-edge boarding put on at a later time. All those little touches and additions did add to the picturesqueness of the buildings, and it had to be considered whether they should not be retained and made use of. Some architects thought that, in renovating a cottage, it should be made to look exactly like its original aspect, but others liked to retain the little touches and additions which had subsequently been made. Personally he thought it was a very good plan to retain them if possible.

MR. BASIL OLIVER said how intensely he had enjoyed the lecture and what a pleasure it had been to him to have seen so many "old friends" on the screen. The author had shown Kersey in Suffolk and had said it was an unspoiled village. It had been so until lately, but he was afraid the rot had set in there. One very good house had been removed entirely and reconstructed somewhere else. That was another sign which showed how urgent was the proposed movement by the Royal Society of Arts.

MRS. COBDEN UNWIN asked what could be done to prevent the County Councils from building the plain, ugly houses they were erecting. Such houses had grown up in a village in Sussex in which she felt interest. The people did not care to live in them; the agricultural labourers could not afford their rents and they found them cold and uncomfortable. The question was, how County Councils could be induced to pay more attention to architectural features, and altogether to improve the type of such houses. In the small Sussex village in which she was interested, her family had had the satisfaction of restoring eight cottages that were derelict and falling into disrepair. They had not made their fortunes by this, but they had given everyone that passed by them the satisfaction of seeing eight charming cottages. There was another danger, that in villages old houses were being removed to make room for new buildings, such as village halls. In the Sussex village she spoke of, an old 16th century house had been converted into the village club and library—the Heyshott Cobden Club—and she had often been told it was one of the most picturesque Clubs in the country. If each village could have some person there who would call attention at once to such happenings she thought in that way there could be saved many of these old cottages, which were now being pulled down, and which represented to many people happy recollections of their childhood days.

MR. T. WILSON thought that to talk to an audience such as was present that afternoon about preserving our old cottages was like talking to the converted. What ought to be done was to get out among those unconverted people who had a kind of pious idea that country cottages were nice to look at, but could not be useful because it was quite impossible to put them into sanitary condition, and so on. What had to be done was to let it be known, by lectures and by evidence, such as had been given that afternoon, that this could be done, and that our cottages were not necessarily the hideous things they were supposed to be in the matter of accommodation. It had been said that it was possible in the future, when the money market of the world had moved from London to New York, that as a last refuge old England would have its picturesque cottages and its old traditions restored and would bring back the Anglo-Saxon race to its birthplace; but if that calamity did happen and if we went on destroying the old traditions and the ancient cottages of the Anglo-Saxon race which we had in our country now, when our American cousins came back to see the remnants of the Anglo-Saxon race, there would not be anything to see. He put that forward as an argument which might very probably appeal to some financial minds and some practical people who were saying that we should end as a race of hotel keepers. From that point of view it was worth preserving our cottages, and it might have some influence in bringing in those who had money to support the good work. The author should get into touch with people of that kind. They could easily be convinced and converted because financiers were very sentimental people. They only had to be talked to in the right sort of way about the traditions of the English

and how magnificent the cottages were, and the thing would be done ; but it meant to say that all those who believed passionately in the preservation of our cottages should get together and start to work as soon as possible.

MR. GODFREY GILES remarked that one of the great difficulties in connection with the matter was to be able to make old cottages available, without too great expense, with modern necessities and requirements. He had in mind a derelict cottage which had no water, gas, bath, or anything of that sort ; in fact, that was perhaps the reason why it had become derelict ; and the economic question at once arose as to what the cost would be to put it into order for the occupation of working people. The only way seemed to be for those who were interested in old cottages and who did not want them pulled down, to put them in order and have the pluck to take them either for their own occupation, or to chance whether they could get a rent for them which would pay. He thought one would undoubtedly be able to recover an economic rent because there were many people who would be quite willing to pay an adequate rent for a charming old cottage that had been repaired and put in good order ; but he quite agreed with the author that the repairs and modernisation and so on must be done in such a way as to entirely preserve if possible the original effect and character of such buildings.

MR. ERNEST HERBERT said some few years ago he had been asked to alter 18 cottages in a group at Kenilworth, and he had been able to do the work so as to make them habitable, and with financial success. For a few more shillings a week in rent, the tenants had been provided with good, sound and healthy abodes, to the satisfaction of the Local Authority. In renovating old cottages several things had to be done. First of all, the cottage generally had to be dug out of the ground ; the earth might have accumulated up to 5ft. round the walls. The staircases were generally dangerous and unfit for use. Then again, headway was a difficulty in some cases, and more window space had to be provided in order to comply with modern requirements. But he was quite sure that in almost every village in England there were cottages to be saved which ought to be saved, and it was the duty of everyone interested in the preservation of our old cottages to do all they could to promote that end.

He had great pleasure in moving a hearty vote of thanks to the author for his paper.

MR. N. B. WARNER BROMLEY, in seconding the vote, drew attention to the fact that in our villages cottages had to be provided for labourers who could only afford to pay very little rent. That was one of the problems which faced landlords of such property in its upkeep. In many cases old cottages had been repaired and modernised for the purpose of housing somebody who had come to the village to buy an old cottage. Cottages had to be provided for the labourers, and it was not desirable that cottages should be bought up by someone who only desired to reside in them for a short time in the year. The difficulty was for the landlord, out of £5 a year rent which he got, to preserve his old cottages in their ancient beauty, and also to bring them up to the modern standard. Any help which could be given in that direction would be valued by those who loved the old places, but who also had the great difficulty of meeting the financial problem involved.

He also desired to stress the point of educating not only members of the Royal Society of Arts, but owners of such property, who should be made to realise what treasures they possessed in their villages.

The vote of thanks was carried unanimously.

THE AUTHOR, in acknowledging the vote, said the aim had been that evening to get a practical scheme forward for the saving of our village architecture; and all the problems which had been mentioned in the discussion would disappear before a definite movement which said it should not die. He was convinced that all that was necessary was the will to live. The will to live was the great physician; it was far better than all the British Pharmacopœia; and if an authoritative and strong body, speaking with all the influence of such a great Society as the Royal Society of Arts behind it, said the cottage architecture of England should not die, then, with the interest and support of bodies like the Society for the Protection of Ancient Buildings, and with such inspired enthusiasts as Mr. Powys, Mr. Basil Oliver, Mr. Tipping, and others, he was convinced it would not die.

He thanked the audience most sincerely for their attendance under the prevailing circumstances, and he thought it was a great privilege to them all to realise that in an emergency such as the present, they had chosen, while Rome was said to be burning—but was not even singed—to sit quietly and placidly together—carefully thinking out a noble and ideal scheme for the preservation of our old cottages—a subject which was a very vital part of the history of England.

The meeting then terminated.

AGRICULTURAL REVIVAL IN THE DUTCH EAST INDIES: NATIVE RUBBER PRODUCTION.

Writing on the general economic situation of the Dutch East Indies the British Commercial Agent at Batavia says that the outstanding feature last year was the revival of the agricultural industries. In Java *tea* planting has been extended, and many applications have been received for permission to rent from native holders irrigated rice land for the extension of *sugar* plantations, and several concessions for this purpose have been granted. Irrigation works undertaken by the Government have resulted in a large tract of country centering around Krawang in West Java being rendered suitable for the growing of sugar, and a concession for this purpose has been applied for by a British company. The importance of the founding of a sugar industry in West Java cannot be overestimated.

The extension of the cultivation of *agave fibre* or *sisal* brings this industry to the front rank of important cultures, while for new plantations now being developed no expense is spared, the very latest machinery and best equipment known being laid down, so that their success seems assured.

In Sumatra also agriculture is making great headway; particular mention should be made of the success of the *tea* gardens centering around Permatang Sianter, where the largest tea factory in these islands was completed in 1922. In West Sumatra residency in the neighbourhood of Kepahiang, *coffee* cultivation is increasing, also at the foot of the Dempo mountain in the Palembang residency, where there is excellent volcanic soil suitable for the growing of coffee, tea and *cinchona*.

On the East Coast and in Atjeh and Dependencies much interest is being shown in the cultivation of *oil palm*, and this industry is increasing rapidly. The planting of *rubber* trees by the inhabitants throughout the Outer Islands is of the greatest importance, and a native industry has come into being based on scientific knowledge.

Native Rubber.—The number of trees planted yearly is amazing, and there can be no doubt that the native rubber industry of the Netherland East Indies is going to have a yearly increasing influence on the world's rubber markets. The belief in some quarters that this is an ephemeral industry, fostered by present rubber prices and restriction of output in the Straits Settlements and Federated Malay States, is not substantiated. It is an industry which has come to stay. A visit to Djambi, Palembang residency or South Borneo will show the sceptical Straits rubber planter that there is no question of killing this industry by over-tapping, shortage of native labour or such other difficulties as are imagined by those who have not seen the districts in question. The number of rubber trees belonging to natives was estimated at 80 million at the end of 1922.

In the past the term native rubber has been used to express a product collected by natives and obtained by tapping rubber trees found in the jungle of tropical countries; the term as now used in the rubber trade in the Far East means rubber obtained from the latex of the *Hevea Brasiliensis*, the only difference between estate and native rubber being that the former is cultivated and manufactured under European supervision, whereas the latter is obtained from trees owned by natives and marketed by them in a cruder state.

During the past seven years rubber planting by natives has spread to all parts of the Dutch East Indian Archipelago, and is proving a most remunerative occupation; it is bringing wealth to the population, and in the Djambi and Palembang residency of Sumatra, also South-East and West Borneo, this industry is of national importance.

The writer has recently returned from an extended tour of Sumatra, covering over 2,000 miles, where he was able to make an exhaustive study of the native rubber question.

The opinion so often expressed that the producing trees will be killed by over-tapping appears to be without foundation; nowhere in the vast area examined was there any sign of over-tapping or disease; the native gardens were well cared for, the rubber trees are well planted out and tapped according to the usual estate practice. It was particularly noticeable that trees under five years old were not tapped at all.

The present official estimate is that there are between 90 and 100 million rubber trees owned by the native population, of which it is doubtful if 20 per cent. have yet been tapped. There appears no reason whatever why planting should not go on increasing in Sumatra and Borneo; the land that is available is still practically unlimited, and the natives have a totally free and uncontrolled right of occupation of new ground.

The present price of rubber is encouraging; the native rubber industry and those whose gardens have been producing for a considerable time are already wealthy. It is, in fact, no uncommon occurrence to see natives who a few years ago had not a rag to their back now driving from village to village in Ford cars. The fortunes of a few have been an incentive to many to start rubber gardens; while trees already planted assure a continued increase in production for many years to come.

The quality of native rubber is improving; almost every homestead is now provided with hand rollers, while great care is being taken in manufacture, which, though still crude, is based upon the practice adopted by estates. It has been proved that native rubber is an easily marketable product, and already many of the world's leading manufacturers of rubber articles are keen purchasers.

The questions of collecting and marketing offer no difficulties. The Chinese, who are renowned for their power of organisation, have established a chain of

buyers throughout the rubber residencies, who are in "Kongsie" with Chinese exporters in all outlet ports; in fact, the commercial organisation is complete, and ends at the blanket mills in Singapore.

It is impossible to form any estimate of production costs, but there is no doubt that the price now obtainable assures a handsome profit to all connected with this industry, and will have to drop very considerably before planting will be discouraged.

The general opinion expressed in the Dutch East Indies, adds the British Commercial Agent, is that the rubber trade will follow in the lines of the copra trade, and yearly become more and more a native culture; how far estates will be able to compete with the native growers remains a problem for the future.

INTERNATIONAL HOUSING AND TOWN PLANNING CONGRESS.

The next International Congress will be held in Vienna from September 14th to 19th, 1926, in accordance with the decisions taken at the Amsterdam (1924) and New York (1925) Congresses, and in response to the invitations of the Mayor and City Council of Vienna, supported by the Austrian Government and the Austrian housing and town planning organisations.

The principal subjects for discussion will be:—

(*a*) Examination of the conditions of land tenure in each country and of how far they permit practical results respecting town and regional planning.

(*b*) The rational distribution of cottage and tenement houses.

Under the first heading will be discussed land ownership and leases and the uses to which land may be dedicated in town and regional plans, the acquisition of land (whether by private treaty or compulsory powers) where necessary for the plan, the exchange of sites, and all the land problems that it is necessary to solve so that the plans as drawn up may be actually achieved. It also involves the study of regional and town planning in relation to existing and potential land values, a study which is made the more necessary by the recent growth of regional planning and the larger areas that are now envisaged.

The second subject will provide for comparisons between the two types of housing development, their appropriateness under varying conditions, their respective costs, and their social advantages and disadvantages. It also involves consideration of the place in regional and town plans of both types of building and the relation of housing to town and regional planning.

The provisional programme, copies of which may be obtained from the Organising Secretary, International Federation for Town and Country Planning and Garden Cities, 3, Gray's Inn Place, W.C., shows that a number of well-known experts from various countries have promised to present papers.

Vienna is itself of much interest from the point of view of town planning and housing. It is the centre of an important region and has the status not only of a city but of a state of the Austrian Republic. The city has had a zoning plan since 1893 and a general plan since 1894. It has its large belt of forest and meadow amounting in all to 11,000 acres. A new town planning scheme is being prepared for the large town area on the left bank of the Danube.

There will be a specially selected International Exhibition dealing with the congress subjects. There will also be an exhibition illustrating the development of Vienna from earlier times and suggestions with regard to its future, also some characteristic Austrian house and town plans.

GENERAL NOTES.

ARTISTS' OWN EXHIBITION.—A novel and interesting experiment is to be tried at an exhibition to be held at the Spring Gardens Gallery from June 12th-26th, under the auspices of the I.3A Club, an association, presided over by Sir John Lavery and working on co-operative lines, of members of the Three Arts, who aim, *inter alia*, at the popularisation of Art. The artists and sculptors who exhibit their works will not price them, but will sell them to the highest bidders. This plan has been adopted as a reply to the complaint that artists charge too much for their pictures. A number of well-known painters and sculptors have promised to exhibit, and it is hoped that the exhibition will have the effect of stimulating popular interest in art and of inducing the public to purchase pictures at their own prices.

PROCEEDINGS OF THE OPTICAL CONVENTION, 1926.—It is expected that the proceedings of the Optical Convention will be published not later than August 1st next, and that they will, therefore, be available during the meeting of the British Association at Oxford. Owing to the large number of papers read at the Convention, and the consequent size of the proceedings, it has been found necessary to fix the price at thirty shillings. Orders should be addressed to the Secretary, The Optical Convention, 1926, 1, Lowther Gardens, Exhibition Road, London, S.W.7.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JUNE 14..Faraday Society, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 2.30 p.m. and 7.45 p.m. Part I.—Explosive Reactions Considered Generally. 1. Dr. W. E. Garner: Introductory Survey. 2. Professor H. B. Dixon, J. Harwood and W. F. Higgins: "On the Ignition Point of Gases." 3. Professor W. T. David, "Radiation in Gaseous Explosions." 4. (1) Dr. S. W. Saunders and Dr. W. E. Garner, "Ionisation in Gas Explosions." (2) Communication from Dr. S. C. Lind, "Ionisation and Gas Explosions." 5. Professor R. V. Wheeler and Dr. W. Payman, "The Uniform Movement of Flame." 6. Professor W. A. Bone, F.R.S., "Explosions at High Pressure." 7. Dr. Colin Campbell and Professor H. B. Dixon, "Explosion Wave in Cyanogen Mixtures." Part II.—Explosive Reactions Considered in Reference to Internal Combustion Engines. 8. Sir Dugald Clerk, "Introductory Survey." 9. Professor W. T. David, M.Inst.C.E. "Combustion in Gas Engines." 10. H. T. Tizard "Explosions in Petrol Engines."

Geographical Society, at 135, New Bond Street, W. 8.30 p.m. Major E. W. Nesham, "The Alaska Boundary Demarcation."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Prof. Dr. Howard A. Kelly and Rev. Dr. David M. McIntyre, "The Silence of God—How is it explained?"

TUESDAY, JUNE 15..Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Dr. E. C. Snow, "Some Observations on Trade Forecasting and Prices."

Asiatic Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.30 p.m.

University of London, at King's College, Strand, W.C. 4.30 p.m. Dr. J. W. Pickering, "The Constituents and Coagulation of Blood Plasma." (Lecture IV.)

WEDNESDAY, JUNE 16..Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. 1. Messrs. J. E. Clark, I. D. Margary and R. Marshall, "Report on the Phenological Observations in the British Isles from December, 1924, to November, 1925." 2. Mr. S. Morris Bower, "Report on Winter Thunderstorms in the British Islands from January 1st to March 31st, 1925." 3. Dr. Edward Kidson, "Abnormal Rates of Ascent of Pilot Balloons in the Lower Levels of the Atmosphere at Melbourne."

Philosophical Studies, British Institute of, at King's College, Strand, W.C. 5.30 p.m. Prof. S. Radhakrishnan, "The Philosophic Basis of Hinduism."

University of London, at the School of Oriental Studies Finsbury Circus, E.C. 5.15 p.m. Prof. A. J. Toynbee, "The International History of the Modern Islamic World." (Lecture III.)

THURSDAY, JUNE 17..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, Burlington House, W. 8 p.m. 1. Messrs. A. Hassell and C. K. Ingold, "The Chemistry of Polycyclic Structures in Relation to their Homocyclic Unsaturated Isomerides. Part VII.: Tautomerism Corresponding with that of Nitrosophenol and Quinone-Oxime in the Dicyclopentane Series." 2. Messrs. F. R. Goss, C. K. Ingold and I. S. Wilson "The Nature of the Alternating Effect in Carbon Chains. Part VIII.: The Nitration of some Benzylamine Derivatives with Special Reference to the Respective Roles of the Ions, Salts and Bases." 3. Mr. E. L. Hirst, "The Structure of the Normal Monosaccharides. Part V.: Fructose." 4. Messrs. W. N. Haworth and E. L. Hirst, "The Constitution of the Disaccharides. Part XI.: The Relationships of Fructose, γ-Fructose and Sucrose."

Royal Society, Burlington House, W. 4.30 p.m.

Tropical Medicine and Hygiene, Royal Society of, at 11 Chandos Street, Cavendish Square W. 7.45 p.m. Colonel S. P. James, M.D., "Epidemiological Results of a Laboratory Study of Malaria in England."

FRIDAY, JUNE 18..Philosophical Studies, British Institute of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.30 p.m. Annual General Meeting. Address by the Earl of Balfour.

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Dr. D. R. Grantham, "The Petrology of the Shap Granite. Mr. George W. Young, "Notes on the Shoshone Valley, Yellowstone National Park, U.S.A."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Mr. Seton Gordon, "The Golden Eagle and its Neighbours."

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REGISTERED AS A NEWSPAPER.

Royal Society for the Encouragement of Arts, Manufactures, and Commerce.

The Royal Society of Arts was founded in 1754, and incorporated by Royal Charter in 1847, for the Encouragement of the Arts, Manufactures, and Commerce of the country.

At present the Society numbers about 3,500 Fellows. The annual subscription is Three Guineas, the life subscription Thirty Guineas. There is no entrance fee.

Fellows are entitled to be present at all meetings of the Society. These include the Ordinary Meetings, held every Wednesday during the Session, when papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed; the Meetings of the Indian and Colonial Sections, at which subjects connected with our Indian Empire and the Colonies and dependencies are considered, and the various lectures on technical subjects delivered under the Cantor and other trusts. Fellows also receive a weekly copy of the *Journal* which contains full reports of the Society's proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce; and they are entitled to the use of the library and reading room.

Proposal forms and further particulars relating to the work of the Society, may be obtained from the Secretary, Mr. G. K. Menzies, at the Society's House, John Street, Adelphi, London, W.C. (2).

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3839 VOL. LXXIV.

FRIDAY, JUNE 18th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One-hundred-and-seventy-second Annual General Meeting, for the purpose of receiving the Council's Report and the Financial Statement for 1925, and also for the election of Officers and new Fellows, will be held, in accordance with the By-laws, on Wednesday, June 30th, at 4 p.m.

(By Order of the Council),

GEORGE KENNETH MENZIES,

Secretary.

INDIAN SECTION.

FRIDAY, JUNE 11TH, 1926. SIR FRANCIS E. YOUNGHUSBAND, K.C.S.I., K.C.I.E., LL.D., D.Sc., in the chair.

A paper on "Travels in the Kara-koram Himalayas" was read by CAPT. B. K. FEATHERSTONE.

The paper and discussion will be published in the *Journal* dated July 16th.

REPRINT OF CANTOR LECTURES.

The Cantor Lectures on "Coal Ash and Clean Coal," by R. Lessing, Ph.D., M.I.Chem.E., have been reprinted from the *Journal*, and the pamphlet (price 2s.) can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A full list of lectures which have been published separately and are still on sale can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, 4th MAY, 1926.

BRIGADIER-GENERAL SIR S. H. WILSON, K.C.M.G., K.B.E., C.B.,
Permanent Under-Secretary of State for the Colonies, in the Chair.

THE CHAIRMAN, in introducing the lecturer, said Mr. Ponsonby was Managing Director of the British Central Africa Company and also a member of the Joint East African Board, and of the Advisory Committee to the East African Trade and Information Office. The audience would agree that they, and especially those who, like himself, had not yet had an opportunity of visiting East Africa, were fortunate in having a man like Mr. Ponsonby present that afternoon to tell them all about the past history of Nyasaland and its future possibilities.

The following paper was then read:—

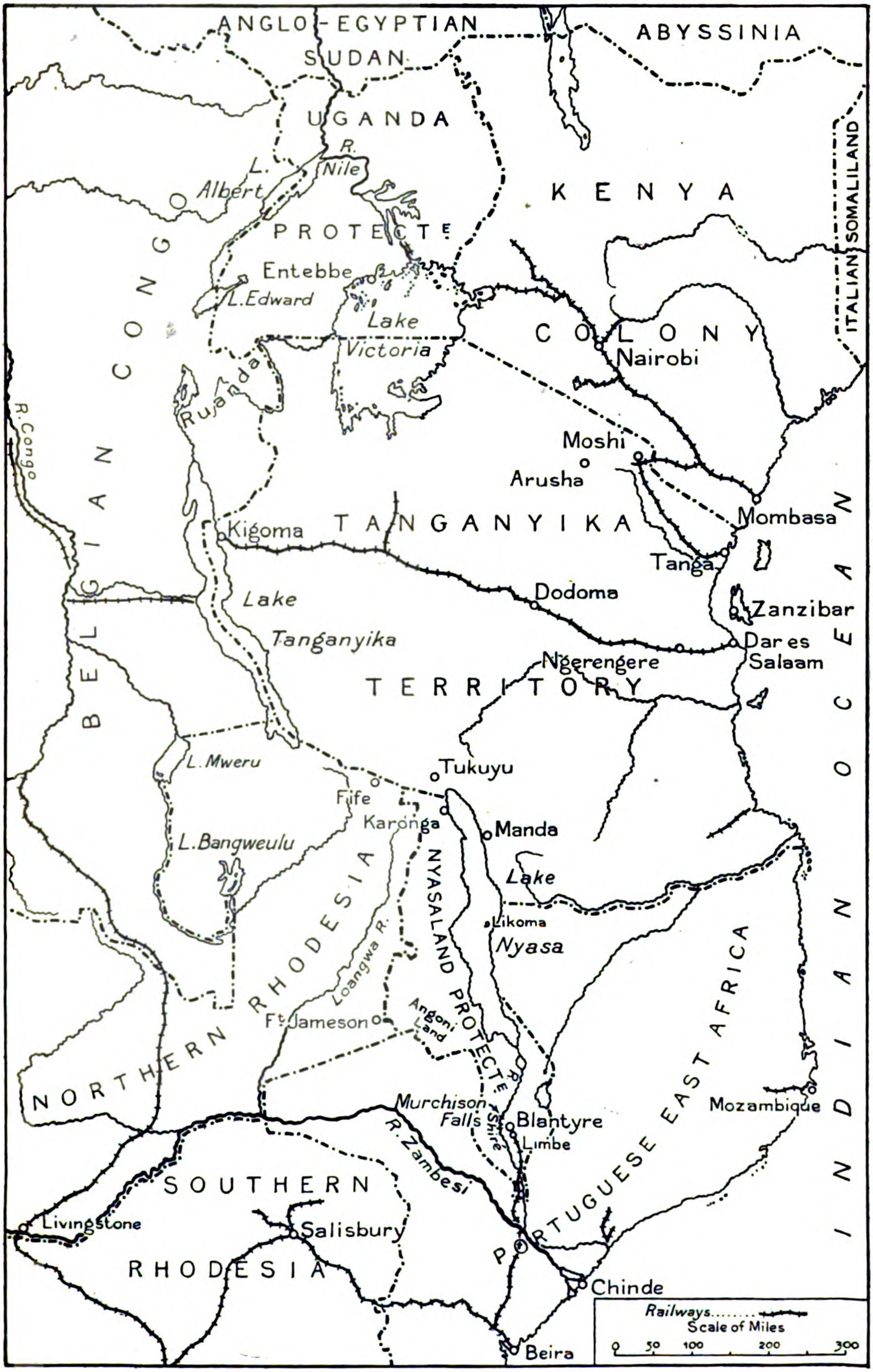
NYASALAND.

By CHARLES PONSONBY.

In the last three years two events have served to drag from obscurity a country little known in the annals of English history.

These two events were the British Empire Exhibition and the visit of the East Africa Commission in 1924. I am sure that there were few of the British public who passed through the East African section of the Exhibition who were not surprised to find Nyasaland among the courts, if indeed they knew of its existence at all, while the fact that the East Africa Commission visited Nyasaland, though only for the short period of five days, must have surprised many to whom East Africa had always implied Kenya, which had been so much in the limelight for the last 15 years, with Uganda and Tanganyika somehow indefinitely connected with it.

While I briefly sketch the history of this remarkable little country—and it is brief, as there are only two or three landmarks—I would ask you to picture to yourselves its main aspects. You will see that it is long and narrow—about 520 miles long and from 50 to 100 miles in width. Of the length, 360 miles by 15 to 50 wide are taken up by Lake Nyasa. The Shiré River runs from Lake Nyasa to the Zambezi, dropping from 1,565 feet to about 100ft., and most of the country through which it passes is potential cotton land. The country most suitable for European settlement is to be found at the north end of Lake Nyasa, in the Angoniland Highlands in the centre and in the Shiré Highlands in the South, but up to the present the settlement in the first two districts is negligible and practically all the development has taken place in the Shiré Highlands. These Highlands are about 90 miles long by 25 wide, with an average altitude of 3,500 ft. They resemble more than anything the Highlands of Scotland, and while the climate is hot and clammy during the



MAP OF EAST AFRICAN TERRITORIES.

rains from December to March, from April to November it is perfect, and you have the combination of the scenery of Scotland and the climate of the Riviera.

I would have you bear in mind also, in view of some aspects of Nyasaland which I will deal with later, that in these Shiré Highlands are concentrated the majority of the European population, and also a very large number of the native population, who of their own accord have left their original domicile in the North of Nyasaland and often in Portuguese Territory, with which as you will see Nyasaland is partly surrounded, in order to settle near the principal European centres. This has an important bearing on the future development of the country.

To turn for a moment to the past. You may well ask why is Great Britain in Nyasaland at all, and if so, why is it of so curious a shape. In other words, if we went there at all why did we not bite off a larger morsel, of a kind more convenient to administer? It really is the old romantic story. We got there by chance; we found that we were of some use to civilisation; we had to stay.

At the time of Livingstone the Portuguese had more or less defined spheres of influence in East Africa, with one exception, and that a narrow strip through which the Shiré River flows from Lake Nyasa to the Zambezi. In this strip the Portuguese flag had never been planted. Lake Nyasa was discovered by Livingstone in 1859, and between that time and, say, 1875, interest in England in this unknown country grew languidly, fostered, however, by the romance of Livingstone's journeys and the missionary enthusiasm which they evoked. During the next 15 years development of the Shiré Highlands was begun first by missionaries and then by planters and settlers. The Livingstonia Free Church Mission was founded on the west shore of the Lake by Dr. Laws, who we are proud to say is still alive and at work even now, 50 years later; the Church of Scotland Mission was founded at Blantyre, and the Universities Mission at Likoma, an island in the middle of Lake Nyasa. The African Lakes Corporation, too, came into existence, a trading company split off from the original mission, whose activities in connection with the suppression of the slave trade I shall refer to below.

The chief difficulty of the missions and of the early pioneers in reaching the country of their adoption in Central Africa was the necessity of passing through Portuguese Territory.

During the sixties, Livingstone had established the theory of the internationality of the Zambezi, but that did not solve the problem, as it was thought that no ocean-going steamer, however small, could get into the mouth of the Zambezi, and therefore it was necessary to leave the ocean steamers outside the bar and come in to land on Portuguese Territory.

In 1889, however, a navigable entrance to the Zambezi at Chinde was discovered, and it was then thought feasible for a small ocean-going vessel to enter the Zambezi, proceed up the Shiré and land her passengers and goods beyond the limits of Portuguese Sovereignty. The fact that Lake Nyasa might be reached

from the sea by way of the Shiré River (a portage of about 70 miles being necessary past the Murchison Falls between the Upper and Lower Shiré) suddenly awoke the Portuguese to the desirability of acquiring the Shiré Highlands, the South end of Lake Nyasa and the Eastern shore of the Lake. They consequently sent their great explorer, Colonel Serpa Pinto, to carry out this project.

Mr. (afterwards Sir Harry) Johnston, then Acting Consul in Portuguese East Africa, was sent by Lord Salisbury to intervene, and shortly afterwards, with Dr. Heatherwick of the Blantyre Mission as interpreter, and Turner, his servant, was speeding as fast as possible up the Shiré to catch Serpa Pinto and tell him of the trouble that would ensue if he proceeded on his expedition.

Apart from any international trouble, the Natives were roused and by no means friendly to the Portuguese. Mr. Johnston above all desired to keep peace and prevent the Makololo attacking them, so he arranged with Serpa Pinto that he was to precede him up the River. Dr. Heatherwick described to me an interview with the Makololo, on the banks of the Shiré. Amid somewhat unfriendly demonstrations the Englishmen landed and were led up to the Chief's hut. Here a chair was brought, and as Turner, the servant, was a man of very fine physique, it was offered to him as the chief White man. The mistake was explained, two more chairs were brought and Mr. Johnston and Dr. Heatherwick took their seats. The meeting was tense with hardly veiled hostility. Another chair was brought for Turner. He sat down, and owing to his size the chair collapsed on to the floor. The natives rocked with laughter, and all hostility vanished. Such is the African native.

Johnston pushed on, and shortly afterwards the Shiré Highlands up to Lake Nyasa were declared to be a sphere of British influence, and the Portuguese Government, as a result of strong representations from Great Britain, withdrew their Expedition.

In 1891 an agreement was reached which definitely demarcated the frontiers between Portuguese East Africa and what was called the British Protectorate of the Nyasaland District.

It will be seen, however, that while boundaries might be settled with the Portuguese, there was still a vast no man's land to the North West. About this time (1889) the scramble for Africa began, and Bismark indicated that Great Britain should leave to German enterprise the Northern half of Lake Nyasa (north of 12th degree of south latitude) and the eastern half of Tanganyika. Leopold II also indicated that the Belgian sphere of influence would meet the German sphere at the South end of Lake Tanganyika.

Mr. Johnston, imbued with Rhodes' Cape to Cairo scheme, was anxious to secure the South end of Lake Tanganyika, so as to complete the link with Uganda, by making a treaty with Ruanda and Burundi at the North end of the Lake, but although he managed to accomplish this, the Anglo-German

agreement of July, 1890, by defining the boundaries and spheres of influence, gave this intermediate region to Germany, and postponed for a generation the realisation of an all-red block from Cape Town to the Nile. Though taken out of its sequence of time, it is interesting to record that even on Nyasaland the Kaiser cast envious eyes. We learn from Sir Sydney Lee's biography of King Edward VII that in 1898 the Kaiser actually suggested to Lord Salisbury that, in exchange for the Tonga Islands and Samoa, the British Government should cede to Germany Walfish Bay and, what interests us more, Blantyre, in Central Africa. Fortunately the project fell through.

While England was engaged in keeping other Nations out of Nyasaland and the territory to the North, it will be noticed that I have hardly mentioned the real reason of her being there at all, namely, the suppression of the slave trade, which still went on in the country bordering on Lake Nyasa. All through this period fighting with Arab Slave Traders and with native tribes continued. Time does not permit me to tell of how, in 1882, the African Lakes Corporation were hemmed in by Arabs at Karonga, how the chief inhabitants of Nyasaland sat round a table at the Blantyre Mission and sent a petition to Capt. (now Sir) Frederick Lugard to undertake the rescue of the Fort, and of the many years of desultory fighting until 1896, when the Slave Trade was finally exterminated and the various Native Chiefs (mainly Yao and Angoni) subdued. It is a long history of difficulty and hardship handled by few men and with often poor resources.

During this time, however, the whole country to the North-west came under British control, mainly through the energy of Sir Alfred Sharpe, but instead of being added to Nyasaland it was included in the Charter of the British South Africa Company, and although at first administered by Nyasaland, it passed in 1895 under the active administration of the Chartered Company who, however continued to subscribe £10,000 per annum towards the expenses of Nyasaland for a further 14 years.

And so, between 1890 and 1897 the country settled down; the name of the Protectorate was altered to British Central Africa in 1893 (being changed again to its present title of Nyasaland in 1907); a Customs system was inaugurated and a 3/- hut tax introduced. During this time also the alienation of land by various Chiefs to Europeans was carefully examined by Sir Harry Johnston. In most cases the Chiefs and Tribes confirmed the grants that they had made, and freehold titles, called certificates of claim, were issued. Though some large tracts of land were purchased for what would seem thirty years later to be a mere song, yet, if we come to think of it, land 300 miles from a railway or coast in the middle of Darkest Africa, and lost amid hordes of wild savages, was hardly worth ½d. per acre or really anything at all. Between 1880 and 1890 a man must have been a great optimist to think that a concession of land in the middle of Africa would ever be of any value.

A concession was often made by a Chief in return for the protection which he had received from the White man against his hereditary enemies, but it may be of interest to record the fact that, in two cases at any rate, large tracts of land were purchased without the least desire for profit, but in order that patriotic Englishmen might have large stakes in the country, which would provide a reasonable excuse for demanding the protection of the British Government in the event of any claim on the territory being made by the Portuguese.

We have now reached the beginning of the present century when the country's situation can be summarized in a few words. Peace everywhere. A small but active European population of, perhaps, 200 Whites engaged mainly in growing Coffee (16,900 acres were under coffee in 1900); communication between Lake Nyasa and the outer world established by means of stern-wheel steamers on the Zambezi and Shiré Rivers plying right up to the Lake; over 400 miles of roads made; the Natives trained as artisans and fine townships erected through the country.

Its progress since 1900 up to the present time may be soon recorded. The census figures for 1901 and 1921 show the following changes :—

	Europeans.	*Asiatics.*	*Natives.*
1901	301	115	736,724
1921	1,486	563	1,199,934

The fact that the country was so difficult of access for any except pioneers and missionaries until 1910, and that most of the remaining period was taken up by the War, would account for the slow increase in the White population. With regard to the Native population, though the figures for the 1901 census may not have been very accurate, the increase in 1921 is remarkable, having regard to the fact that considerable numbers of Natives died in the War, while a severe scourge of influenza in 1918 was responsible for a mortality the extent of which it was never possible to estimate. It may be mentioned that the population of Nyasaland of 31 Natives per square mile compares with 33 in Uganda, 11 in Kenya and Tanganyika, and 3 in Northern Rhodesia.

During these years, also, the cultivation of crops such as cotton, tobacco, tea and sisal, began, and the economic progress of the country is shown by the following comparisons :—

	Total value Exports. (excluding specie.)	*Imports.* (excluding specie, Govt. stores, and Railway material.)
1901	£21,739	£116,751
1924	£564,007	£548,156

This is not the occasion for a dissertation on the various crops, but Nyasaland furnishes such a practical example of the effects of Empire Preference that I think that you would be interested to hear it. Before 1919, Empire tobacco leaf paid exactly the same duty as American or other foreign tobacco. In

1919 a Preference of one-sixth of the duty was given, which was increased to one-quarter in 1925, so that Empire leaf now pays duty at the rate of 6/2 per lb., as against 8/2 for foreign leaf. In Nyasaland tobacco succeeded coffee as a profitable crop about 1906, and in the year when the Preference was first granted there were under tobacco about 9,386 acres, and the amount of tobacco exported was 4,340,000 lbs. Owing to the slump following the boom years at the end of the War, the planters' barns in Nyasaland and the warehouses in England were glutted with Nyasaland tobacco and the market was practically stagnant. Since 1921, when the effect of the Preference began to be felt, a remarkable change has come over the situation. In 1924, when 20,590 acres were under tobacco, the exports rose to 7,044,000 lbs., and even in 1925, which was the worst season on record, they remained at about the same figure. The old stocks in England are practically all absorbed, and given good weather and a careful attention to the quality of tobacco shipped, I can see the export of leaf up to 20 to 25 million lbs. in a very few years—the increase entirely due to the granting of Empire Preference, which, as you know, has also enabled the smoker in England to get some of his smokes more cheaply. There is no doubt that the stabilisation for ten years of the present Preference, as indicated in the Budget, will give an additional stimulus to tobacco growing in Nyasaland, which, with the exception of India, where the quality of leaf is different, is the principal source of supply to this country of Empire leaf.

During this period, too, Nyasaland ceased to be an inaccessible country in the middle of Africa. In early days, as I have mentioned, the only entrance was by ocean or coasting steamer to Chinde, by stern-wheel steamer up the Zambezi and Shiré Rivers, by so-called house boat to Katungas, and then 20 miles by foot or machila to Blantyre. At the greatest possible speed it would have been possible to get from Beira to Blantyre in 10 days, but the normal period was one month or more. Between 1904 and 1915 the Shiré Highlands Railway and the Central African Railway were built from Blantyre to the Zambezi, and in 1922 the Trans-Zambezia Railway (misnamed so far as it only reaches the Southern shore of the Zambezi) was completed, so that now the total distance between the centre of Nyasaland and the sea is only 350 miles, and takes 36 hours, the intervening night being spent on a steamer on the Zambezi. It is satisfactory to those who have so long advocated the bridging of the Zambezi to know that at last this is in sight, and one can forecast that in a few years it will be possible to travel without change of carriage from Cape Town to Blantyre. It is interesting to notice the great and immediate increases in exports and imports of Nyasaland in the years which followed the building of the two Railways, and to be able to prophesy with absolute safety a further increase in prosperity as soon as the last link between Nyasaland, the sea and South Africa is completed.*

* The total value of exports and imports increased by £177,500 within two years of the completion of the Shiré Highlands Railway, while the increase in the year following the completion of the Central Africa Railway was £230,700.

Before I pass to a consideration of the future, let me lay emphasis on the vast amount of pioneer work which has been done by private companies and individuals with very slender resources. Here no Cecil Rhodes put his fortune at the disposal of the country; here the British Treasury did not, as in the case of Uganda, supply a Railway. It was the pioneer work of the African Lakes Corporation that sealed the doom of the Slave Trade and disclosed the possibilities of opening Lake Nyasa and Lake Tanganyika to British enterprise. It was the British Central Africa Company assisted greatly by Lord Faringdon (and in the case of the Central Africa Railway by other private subscribers) who brought the railways to Nyasaland, and with comparatively little support from the Government opened the country, and it was these Companies and other private companies and individuals and the missions who all these years have borne the chief burden of development, who have taught the natives the elements of work and who have spent much money and toil in proving which crops can profitably be grown. It is gratifying to these pioneers that such large corporations as the Empire Cotton Growing Corporation and the Imperial Tobacco Company are now interesting themselves in the country and placing at its disposal not only their financial resources but also their great stores of science and experience.

THE FUTURE—GEOGRAPHICAL.

Up to this point I have tried to conduct you through the few short years which connect the obscure and uncivilised past of Nyasaland with its present position on the edge of a great future. You will remember that at the beginning of this paper I referred to her curious geographical situation, an enclave hemmed in to the South, West and East by Portuguese East Africa, and attached on the North-east to Tanganyika, and on the North-west to Northern Rhodesia. Now, Northern Rhodesia (formerly administered by the British South Africa Company) has recently come under the Colonial Office, and no doubt those who administer N. Rhodesia and possibly those who live at Livingstone, the capital, might object to any suggestion made for a reduction in the size of their territory. But an examination of the map will show the spheres into which Northern Rhodesia is divided. N.W. Rhodesia is in direct communication by rail with Salisbury and the South. The main avenue for communication, between the capital at Livingstone and the sub-capital in N.E. Rhodesia at Fort Jameson is by rail from Livingstone to Beira, then up to Limbe in Nyasaland and then 300 miles by road to Fort Jameson, a total distance of about 1,500 miles. The principal produce of N.E. Rhodesia, mainly tobacco, of excellent quality, as well as any minerals which may be developed, comes, and must always come, from there to the Nyasaland Railways, as the shortest route to the sea. It is important, also, to notice that the Natives of N.E. Rhodesia have many points in common with the Natives of Nyasaland. (Sir Alfred Sharpe will confirm this, as he

was responsible in early days for the Treaties made with many of the tribes).

On broad lines, then, it would seem that there is the strongest possible case for enlarging the borders of Nyasaland by bringing into it N.E. Rhodesia up to the Luangwa River, and possibly even further West, as far as the Belgian Congo. There are two main difficulties. The first is, that N.E. Rhodesia is likely for some years to prove a financial burden, and as no further taxation could be imposed on the Europeans and Natives of Nyasaland, this burden, which already exists, will have to continue to be borne by the Imperial Treasury for a few years. The second difficulty is the fact that all Northern Rhodesia is in the Customs Union of South Africa, while Nyasaland is not. Being a member of the Customs Union was important to N.E. Rhodesia so long as the greater part of her tobacco was sold in the Union, but Empire Preference again has made it possible for the planters to find a good market in England, and I cannot help thinking that if the amalgamation of Nyasaland and N.E. Rhodesia were effected, the manifold benefits which would accrue would amply repay those inhabitants of N.E. Rhodesia who might feel a small shock at first at the change in the name of the country of their adoption. Of course, if this was contemplated a commission would have to decide what part of N. Rhodesia should come into Nyasaland, and the decision would be based mainly on the position of the various native tribes, and on what might be hereafter the commercial watershed of that large tract of country whose mineral potentialities have lately attracted the attention of important mining groups. It is obvious that the people of N.E. Rhodesia and Nyasaland would have a far greater say in the Councils of the Empire if they formed one large Dependency instead of the two small administrations which exist at present.

Nyasaland is now a very small, isolated country, independent of its British neighbours, S. Rhodesia and Tanganyika, as regards its transport, customs and Government. The East Africa Commission hoped to link up Northern Rhodesia and Nyasaland with the rest of East Africa by means of a railway from the Central Railway of Tanganyika Territory to Lake Nyasa, and it is possible that a line will be built from Dodoma to Fife, from which at a future date, by a tortuous and mountainous route, a branch might be brought down to the Northern end of Lake Nyasa at Karonga,. It is doubtful, however, whether this will materialise for many years, and any way, as soon as the Zambezi Bridge is built, it is practically certain that the present Nyasaland Railways will be extended to the Lake, or linked up with the Lake by dredging the Upper Shiré, which has now silted up, so as to form a through waterway. In other words, the outlet of all produce and for all trade from the whole of Nyasaland as it exists at present and from all the Southern part of N.E. Rhodesia, must always be through Nyasaland to Beira. The question arises whether Nyasaland should throw in her lot with the East African Dependencies, or with Southern Rhodesia, or

remain unattached. In these days detachment is isolation. Nyasaland has suffered from it, and, indeed, until the East Africa Commission all the countries in East Africa suffered from it. There are so many similar problems, such stores of experience and knowledge, especially in connection with agriculture, native education, and diseases of man and animal, that it is essential that those who administer these countries should be able to dip into the common pool. In theory, a country outside a group has access to these stores. In practice, it does not avail itself of them, and if the East Africa Commission did nothing else, and if its report did contain some inaccurate statements, due to a too hurried tour, its recommendations with regard to the pooling of information and the frequent discussions between the various branches of Administration, will, I am sure, be the greatest benefit yet conferred on the countries of East Africa.

I feel that while Nyasaland has much in common with Southern Rhodesia, with whom she shares a common coinage, a common port, and with whom she is connected by railway, yet any closer inter-working under present conditions is not possible. Nyasaland has no object in entering the Customs Union of South Africa ; she is likely to obtain more publicity and, perhaps, financial assistance by being affiliated anyhow for a time to East Africa, and, more important than everything else, her Native problem is her own, and nothing could be more fatal than to adopt at this growing stage in her career a policy for which she is not suited, and to which she might be obliged to conform if she came now under the influence of Southern Rhodesia.

The Future—The Native Problem.

I have left this most important question till the last, because on it depends the whole future of the country, and may I emphasize to the utmost in my power that this is a separate problem in Nyasaland—different from that in Southern Rhodesia, Kenya and Uganda—a problem which, if treated with vision, may give a lead to Tanganyika and bring to Nyasaland a prosperity which she cannot visualise, but if made to conform with systems in other countries where different conditions exist will merely put back the clock, both for Europeans and Natives (but especialy for Natives), for another generation.

It may be advisable to mention very shortly the chief differences in the Native situation in Rhodesia, in Uganda, in Kenya and in Tanganyika. In Rhodesia in many districts there are already definite reserves demarcated, and a Land Commission, established in 1925, has been discussing the question of defining areas outside the Native Reserves with a view to definitely segregating Natives and Europeans. There would seem to be in S. Rhodesia a distinct inclination to extend the present system of Native Reserves. In Uganda you have tribal areas under recognised powerful Chiefs, and a regular system of self-government closely supervised by British administrators. There are comparatively few European planters, and little

land has been alienated to non-Natives, that is, to Europeans and Asiatics. The Chiefs have very great power, and, to put it mildly, the feudal system reigns supreme. In Kenya you have the country split up between European-owned land and Native Reserves, the latter ruled by Commissioners through the Native Chiefs. From these Reserves comes the labour, recruited or voluntary, for the European plantations, and into these Reserves outsiders cannot enter unless authorised. None of this land can be alienated by the Chiefs or Tribe to non-Natives. In Tanganyika there are more or less defined areas belonging to definite tribes, and in some parts the powers of the Chiefs are very strong and the feudal system in effective operation. In others, where the powers of the Chiefs have been removed, the authority is wielded by the local Commissioners. At present, in only one part (the Kilimanjaro district) has European settlement made much progress, and it is in the less known highlands towards Tukuyu which are suitable for European settlement, where Tanganyika Territory may possibly be able to take a leaf out of the book of Nyasaland, the situation of which I will now try to describe.

In Nyasaland, the tribal system died early, mainly I think because those in authority considered that their control was ineffective alongside the power of the Chiefs. They consequently removed the Chiefs, and by so doing removed those through whom, as time went on, they could have issued their orders. With the Chiefs went in most cases the tribal boundaries, and except in parts of the country to the north the tribes are all mixed up, although they may still remain tribal in their village life. But you have the position of a small and narrow country, containing altogether 15 to 20 tribes, of which 5 are important, not living in definite reserved areas, but scattered about in their villages, and in some cases you find individuals breaking off from the villages and living independently.

If there were no White settlers in the country it would be possible for these Natives to continue in a state of semi-barbarism under White administration, but European settlement has come to stay. It is due to the fact that the tribal Chiefs and boundaries have disappeared that there are no Native Reserves in Nyasaland, and when an important Land Commission was appointed to deal with the land question a few years ago they definitely stated that this system of Native Reserves was not suitable and was not wanted in the country. When the Chiefs disappeared the Europeans actually took their place, and the Natives worked—and still work—for them, partly in accordance with the Native custom of Tangata, under which a man had to work for the Chief in return for his place in the tribe, and partly, no doubt, to earn sufficient to pay his hut tax imposed by the British Treasury, in order to make the country self-supporting. This system has continued to the present day and has fitted in to the orderly development of the country. The tribal custom has been automatically utilised so that it has worked out to the advantage of both European and Native. The

European owner has had labour for his plantations and the Native, from contact with the European, has gradually begun to evolve in the slow progress from barbarism to civilisation. The necessity to work, in conformity with tribal custom, and to supply the wherewithal to pay the hut tax, very slowly creates the desire to work in order at first perhaps to make more money with which to buy an extra wife or two, and later to supply the wants which increase as the Native becomes more civilised. Before the White man came the Native's wants were things necessary to his existence, and were obtained by barter and spoliation; as his contact with Europeans increased his wants increased too, and now there are no means of satisfying them but by receiving payment for work done for the Government, for the European, or for himself.

The difficulty is that in Nyasaland the Native has up to now no high-priced crop to sell, but what is more to the point he is only just beginning to want to work at all. That is the difference between the Native of West Africa who has been a natural trader, often in a high-priced and easy-growing commodity such as cocoa, for over 100 years. The native of East Africa has been emerging from barbarism in 35 years. He is now perhaps at the stage of the early Britons, when visited by the Phœnicians, and yet there are some people who want to treat him as if he was exactly the same as a present-day White man. They forget that there are differences in tribal characteristics and customs, that one may be pastoral, another agricultural; they forget that there may be differences in the individual, that one may want to work for himself (as a small holder), while another may prefer to work for others. They forget that in nearly every case ambition as we understand it does not exist, and that in matters which we consider important, such as work, inertia is the prevailing characteristic. They forget that while a native may be cheery, clever and brave in some ways, he is phenomenally stupid and unreliable in others. They forget that with him a contract to work or do anything means almost nothing, and, in short, they forget that because a black man with 35 years of civilization behind him has the same kind of body as a White man he has not, and cannot for many generations, have a similar mind.

It is really wonderful if you think of the progress the Native has made in the time. The Natives of Nyasaland are the best builders and carpenters in East Africa; they are good mechanics under supervision, their physique is good, and within their limits they are loyal to those whom they trust, but take away contact with the White man and in a year or two the whole country would relapse into disorganised savagery. That, however, is not likely to happen. Things are moving fast and all that is wanted now is a definite native policy. It is not difficult to see that between 1890 and, say, 1910, all the energies of Government were directed to getting the country settled and orderly. The opening of the first railway in 1910 made everything move more rapidly, and then the war came which engaged all the attention of the authorities. In addition the country was small and unknown,

and its voice was one crying in the wilderness, while its inacessibility prevented any officials from home from studying the various problems on the spot.

But the time has now arrived for the formulation of a definite policy, and this does centre round the land question.

There are two alternatives. The first is to follow precedent blindly and perpetuate the Zoo theory, in other words, to split up all the unalienated land—and there is a great deal of it, about 21,000,000 acres,—into Native Reserves, gradually building up headmen to be Chiefs, through whom orders from the paramount authority can be conveyed. (I would mention in parenthesis that in this way you are putting back the clock and building on a foundation that has been destroyed).

The other alternative is boldly to strike out a new line. The report of the East Africa Commission, the proceedings of the Conference of the East African Governors at Nairobi, and of the unofficial representatives of the various countries at the Tukuyu Conference, all emphasised that it was to the advantage of East Africa generally that European and Native should work side by side. In fact, it is the only way by which the Native can be gradually civilised and become a useful member of society. Here in Nyasaland these pious expressions can be put into practical operation. The East Africa Commission recommended that all land at present unalienated should be put into a Native Trust, the affairs of which would be administered by a Trust Board composed of Government officials, representatives of the non-official community and representatives of the Natives. This is a move in the right direction, but if the Trust Board were merely to mark off lands for Natives only—in other words, create a number of Native Zoological Gardens, where the loneliness of the White Commissioner in charge would only be relieved by the visits of recruiting agents trying to obtain labour for the plantations and mines—then we are no further on at all.

The Native, perhaps against his own inclinations, has settled down to work and the development process has begun. In fact, he has passed the first stage. He has learnt a little from the European, and at the instigation of the Government he has begun to grow economic crops for sale—at first cotton and now tobacco. These crops can be grown in any native garden, and however much planters may object that if natives grow their own crops for sale it will affect the supply of labour, it would be impossible to prevent them doing so. Indeed, this situation has already occurred in the present year when it is estimated that perhaps 12,000 Natives in Angoniland are growing tobacco. These Natives in other years would probably have gone down to the Shiré Highlands to work on plantations, or perhaps migrated temporarily to the mines in Rhodesia or the Sisal plantations in Tanganyika. The business has started and it is impossible to stop it at the moment. But before the movement extends too far, it is essential that some arrangement should be made by which native production can be

closely supervised. I think that this can be done without an army of Government officials. The Natives of Nyasaland, partly owing to their wandering propensities and partly because they seem to appreciate contact with Europeans, are inclined to verge towards the neighbourhood of European settlement. This has already taken place in the Shiré Highlands, where there exist many European plantations with their own voluntary labour force living on the plantations or in villages near by, in much the same way as happens with large estates or farms in this country. In the Angoniland Highlands and in some other parts there are very large areas equally fertile, equally healthy for Europeans, and there would seem to be no reason why the Government should not encourage small group settlements of Europeans in those areas. Any proceeds of sale of Native Trust land or rental received would go to the Native Trust for the benefit of the Natives. The Native Trust would benefit by the money received, while the Native would automatically benefit by European settlement, which would enable those who wished to work for Europeans to find it at their door instead of walking 300 or 500 miles, while those who preferred to grow economic crops for their own benefit would have the example and supervision of the European at their door to assist them, and also a market for their produce. In other words, the European would become not only a Planter himself, but also a centre for buying at regulated prices the crops of those natives whom he supervised and instructed.

But I would go further than this. I have pointed out that there are some Natives who are quite prepared to split off from their villages and cultivate their own crops by themselves. There are in addition the more advanced Natives who see the prospect of gain and are quite prepared to start their own gardens, hiring other Natives to help them. I do not think that such individual Natives, as they become prosperous through the production of economic crops, would have the slightest objection to paying rent for their permanent holding, and the rent paid, or, in the event of a sale, the purchase money, would again go to swell the coffers of the Native Trust for the benefit of the Natives.

It is, I think, possible that a policy worked out on the lines I have indicated would solve the problem of Native migration, would enable the Government to make use of the European settler to supervise and assist the Native in his growing of economic crops, would gradually build up a fund available for all those matters, such as the improvement in education and health, which are essential to the Native, and would carry into practical effect the suggestions that have been made for the development of the East African Colonies by European and Native alike, and for the benefit of both.

I have tried to depict Nyasaland as it is. It is better off than the adjoining countries from the point of view of population. Its Natives, its soil, its climate, have great potentialities. Its chief requirements are the perfection and exten-

sion of its present transportation facilities, the gradual education of the Native, and, above all, a definite policy, based not on vague sentiment or precedent in other countries, but on specialised knowledge of the country and its inhabitants.

Granted all these premises. I can safely prophesy that in a few years Nyasaland, even with the addition of extra territory, will be self-supporting, will combine the prosperity of the European plantations of Virginia with the prosperity of the Native industry of Uganda, and will prove a lasting monument to David Livingstone, her founder, and to those officials and pioneers who have worked so hard for her well-being and for the credit of the British Empire.

DISCUSSION.

The Chairman read the following letter from Mr. A. Wigglesworth, a member of the Joint East African Board :—

"I much regret that owing to my absence in Italy it will not be possible for me to attend the lecture on Nyasaland to be given by Mr. Ponsonby on 4th May. Knowing how much Mr. Ponsonby is identified with the development of this interesting part of the Empire, which owes its inception to Livingstone, I realise how interesting and instructive his views will prove. I look forward to the time when Nyasaland will be one of the areas which will form the great Federation of British Equatorial Africa, including Tanganyika Territory, Kenya, Uganda, Zanzibar and Northern Rhodesia. The development of this vast area is full of promise."

Continuing, the Chairman said that as one who had only recently taken up the duties of his office, and as one who had not yet had a chance, he was sorry to say, of visiting East Africa, he desired to say what very great satisfaction it had given him to be present that afternoon and to hear Mr. Ponsonby's instructive paper, and also to meet so many people who were interested in the vast British territories in East Africa. He felt that the more opportunities he had in his present position of meeting people from the oversea portions of our great Empire, and of meeting those people who, in the United Kingdom, were closely connected with our oversea Empire, and of hearing their views first-hand, the better able would he be to perform the duties of the office which he had the honour to hold.

Mr. Ponsonby had expressed the opinion that there have been some people, at any rate, who had visited the East African Section of the British Empire Exhibition, who had been surprised to find that such a territory as Nyasaland existed. It would not surprise him personally to be told that Nyasaland was not unique in that respect! But he would ask the audience to remember that, if there were some people in the Mother Country who had somewhat hazy ideas as to the whereabouts of some of the distant Colonies and Protectorates, or who did not even know of their existence, it was, he thought, because in many cases there had been no special reason for, or opportunity of, their being brought into close touch with anything connected with those countries, and not because they did not take the same interest as those present that afternoon in the prosperity and welfare of the outlying parts of the British Empire, or because they were not proud of that great Empire and all that it stood for. It was for that reason, and also to try and remedy any ignorance in that connection which might prevail amongst some of the

people of the Mother Country, that he was a great believer in leaving no stone unturned to improve inter-Imperial communication and to make it possible and easier than it was now for people from one part of the Empire to visit other parts, and to improve in every way the facilities for bringing the people of the Mother Country and of the territories oversea into closer touch. It was also for the same reason that sincere thanks were due to the Royal Society of Arts for organising meetings of the present description, and for getting men like Mr. Ponsonby to come and give an account of their experiences in different parts of the Empire and their ideas as to the future possibilities and development of those territories.

Mr. Ponsonby had stated how the trade of Nyasaland had increased in the last 20 years, and he had also referred to the possibilities of the future. With a good climate, good soil, good lake communications, and, what was even more important, a dense and comparatively well-educated native population, he believed that the Colony had a great future before it, and as soon as something could be done to improve its land communications and the railway systems, in order to give it an outlet to the sea (a question which was at present engaging the very earnest attention and consideration of H.M. Government) he had personally no doubt that the hopes which Mr. Ponsonby had expressed that afternoon for its future development would be amply fulfilled.

Sir Alfred Sharpe, K.C.M.G., C.B., said the author had dealt in a very excellent way with the main problems which faced Nyasaland, and also most of our East African Possessions. The first was transport, which had always been Nyasaland's bugbear from the very beginning—and he had known the country since 1887. Things, however, were very much better than they used to be owing to the enterprise of the British Central Africa Company in building the first railway, and also on account of the building of the trans-Zambezia Railway, due mainly to the enterprise of Mr. Libert Oury. What was wanted now in order to enable the country and its hinterland, North-Eastern Rhodesia, to go ahead was the building of the necessary link of the Zambezi Bridge, and then, after that, the extension of the line to Lake Nyasa, which would give another 400 miles of deep water transport. He knew the question was occupying the attention of the powers that be, and he felt quite sure that it would only be a short time before the work was carried out. Meanwhile the negotiations with regard to the Port of Beira, which was the Port for all Nyasaland and North-Eastern and Southern Rhodesia and Katanga, had now been settled, and that Port was going to be immensely improved by the addition of deep water wharves and by the extension of the present lighter wharves.

There was only one way in which our vast territories in East Africa could be developed, and that was by the provision of cheap transport. It was no use our holding such territories unless we developed them, and cheap transport was the only way in which to develop them, and the only way of providing cheap transport was by means of railways and their bridges, and cheap railway rates in place of the heavy charges which now had to be paid for motor transport.

He quite agreed with the author's remarks about the geographical position of Nyasaland. Co-operation and amalgamation were excellent things, but in his opinion there was very little possibility of Nyasaland produce running up towards Mombasa; it would always run down to Beira.

With regard to native reserves, he did not know from personal experience how they had succeeded in Kenya and Uganda, but so far as Nyasaland was concerned he absolutely agreed with the author in his view. In Nyasaland there was a large population compared with the rest of Africa south of the

Equator—a very good and a very friendly population, and one which was glad to work, up to a certain point. There it was found that wherever the European plantations were the natives liked to come; they did not want to go away. If native reserves were to be established in Nyasaland the present system would be entirely upset, and, he thought, the very excellent relations which existed between Europeans and natives would also be upset.

With regard to education, we had always been very well off in Nyasaland. It had been primarily due to the two pioneer missionaries, Dr. Laws and Dr. Heatherwick, who had done a wonderful work there. They had gone about mission work in the right way. They had not taught the native that he had simply to learn religion, but they had taught him that he had got to be a useful member of society and had to work. Dr. Laws in the North and Dr. Heatherwick in the South had taught thousands of natives to be skilled artisans. At the present time on the Railway the stokers and even engine drivers were, many of them, natives. If in Kenya Colony they had adopted the ideas of Laws and Heatherwick many years ago, they would not have had an Indian problem as they now had. Instead of importing Indian clerks, typists and engine-drivers, they could have employed natives, as Nyasaland had done.

Mr. E. F. Colvile also stressed the absolute importance of transport to Nyasaland. At present there was a railway leading 100 miles into Nyasaland, and it was only within reach of that Railway that any crops which were not extremely high priced could possibly be moved. That meant that over at least two-thirds of the great Protectorate the natives had practically no crops that they could grow for export, or which they could grow economically. Recently tobacco had been developed to some extent in the Southern part of Angoniland, but even then it was only when tobacco reached a high price and when it was of the best quality that it could be moved; and tobacco was not a crop which could be grown everywhere or continually. The one thing which seemed really necessary for Nyasaland was that the native should have the possibility of marketing the crops which he grew, particularly maize and ground nuts. Every native grew those crops, and they could be developed to an enormous extent, and anything which would enable the ordinary native to grow those crops, either alone or in rotation with tobacco, would make an astounding difference to the future of the Protectorate.

Another point he would like to bring out was the difficulty of deciding exactly what policy of native administration was to be followed until it was known exactly how the country itself was going to develop. At present most of the natives had to walk down to the southern half of the Protectorate to work, and our administration was made more difficult by the fact that nearly every male in the northern half of the Protectorate was absent from his village from one to six months during the year. It would be seen what immense difficulties that raised, and how hard it was to inaugurate any very definite policy of native administration so long as the bulk of the male population was absent from their villages, at work or on the road, for so large a part of the year.

Mr. H. S. Fleming, U.S.A., remarked that the matter of the native reserves in Nyasaland had interested him very much. He suggested that some attention should be given to the results of the establishment of native reserves in the United States and Canada. The establishment of reserves in those countries invariably resulted in bringing out in the native the very worst that was in him, and, added to that, the worst that could be got from the whites. The native had always gone downhill as a result of the system of reserves.

MR. H. C. SAMPSON stated he had been in Nyasaland for the last 3 years in connection with the Empire Cotton Growing Corporation. The main problem in the country was to get some rotation of crops if cotton was to be grown. It was impossible to keep on growing cotton year after year on the same land ; it was essential to work in other crops with cotton—cereal crops, for instance, and possibly other more valuable crops, which would pay to export. Nyasaland was a wonderful country in that respect. Cereal crops in Nyasaland grew far better than they did in India with the same amount of cultivation, and the same applied to ground nuts and fibre crops. If the native was going to develop he would have o be taught how to farm. At present he took a piece of land in his village, and when that got tired he moved on to another piece. The agriculture of the country could never be developed unless the native were taught to stick to one piece of land and not to exhaust it. He had to work a rotation of crops to get his living and to earn money from the growing of crops which he could sell in the world's markets.

MAJOR SIR HUMPHREY LEGGETT, R.E., D.S.O. (Chairman of the Dominions and Colonies Section), in moving a hearty vote of thanks to the lecturer for his paper, and also to the Chairman for presiding, said the paper was one of a series which had been delivered over the last 3 or 4 years on the different East African Territories. It also followed papers which had been given by distinguished foreigners on the Congo and on French North Africa. The series had been inaugurated with the definite plan of trying to bring out as far as possible the comparative problems, and one thing which had emerged very markedly had been the danger that would result in trying to treat the different countries of Africa on a sealed pattern basis. Perhaps he might say without disrespect that there were some cranks in the world who would like to lay down general propositions and thrust them through regardless of the differences between the countries concerned—differences between tribes, differences of geographical conditions, communications, crops and so forth. There were such vast differences between the countries, even though they could be shown on the same map, and even though they existed side by side, that such general propositions could not be adopted in regard to all of them. That was one point which Mr. Ponsonby had brought out in his paper.

He would like to thank the author also for another thing, which was distinctly noticeable in his paper, and that was its constructiveness and the definite propositions which it laid down, supported as they were with arguments of much cogency.

He also wished to thank the Chairman for the interest he took in meeting people from overseas and discussing with them the problems and difficulties which they had to face. In coming to the meeting that afternoon the Chairman had given an earnest of his great interest in such matters, for which the audience thanked him very heartily.

The votes of thanks were carried by acclamation.

DR. ARTHUR HAYDON enquired if there was any part of Nyasaland in which there was any table-land, or any part which was favourable for European residence. That was a very important point with regard to the development of the country. In many other parts of Africa all table-land was considered of great importance, especially when it was near any lake.

THE AUTHOR replied that in Nyasaland there were very high healthy table-lands roughly at an average of 3,500 or 4,000 ft., where Europeans could live, and had lived, for the last 20 or 30 years, perfectly healthily. All the modern arrangements for fighting malaria were so well advanced in the country that he could say that the

people there were the healthiest he had seen almost anywhere in East Africa, and perhaps also in South Africa.

He had been very glad to see present Sir Alfred Sharpe, one of the original Governors of Nyasaland and also Mr. Colvile, who was going to be chief Native Commissioner. He wished to express his acknowledgment to Sir Harry Johnston and to Mr. Murray, the compiler of the Government Handbook on Nyasaland, from whose writings he had obtained the history of the country. He desired to thank the Royal Society of Arts for having given him the opportunity of talking about Nyasaland and in doing the best he could to make the country a little more known than it was at present. He also thanked the audience for their presence on such an occasion. It was a great compliment to him to have had so good an audience under the difficult circumstances of the General Strike.

MAJOR BLAKE TAYLOR, who was unable to remain for the discussion, writes :—

"As a member of the Railway Sub-Committee of the Joint East African Board, I have been very interested in studying the possible development of the several East African States, and in my opinion the question in Nyasaland is very largely, one might even say almost entirely, a railway one.

I agree with Sir Alfred Sharpe that Beira is the Port for Nyasaland, and it will not be economic to try and force traffic through Dar-es-Salaam.

In order to develop this country, extension of the present railway system northwards and to the west of the Lake is essential. But this extension must wait on sanction being given to the construction of the Zambezi Bridge, and this again must await the development and sanction to the linking up by rail of the Tete coalfields.

Ordinarily, the construction of such a bridge would only be economically possible if a sufficient coal traffic could be anticipated to warrant so large an expenditure as £750,000—but the case is not an ordinary one.

A grant-in-aid is being given by the Mother Country to meet the annual deficit in the Budget of the Colony, the total sum advanced being now close on £1,000,000—and this must continue for all time with no probability of repayment unless the country be economically developed, which again cannot be unless cheap transport be available to permit of the economic export of the produce of the country.

It will, therefore, be sound finance for the Treasury to join in a guarantee for any loans issued for the construction of *Through Railway Communication to a Port* so as to ensure that development which will make for the prosperity of the Colony and thus enable the balancing of the Budget and closing down of the Grant-in-Aid. Nor should be overlooked the advantage to our home manufacturers of increased supplies of raw materials with the call in return for manufactured goods."

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JUNE 21..Geographical Society, at 135, New Bond Street. 3 p.m. Anniversary General Meeting.

Architects, Royal Institute of British, 9, Conduit Street. W. 8.30 p.m. Presentation of the Royal Gold Medal.

TUESDAY, JUNE 22..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. V. Gordon Childe, "The First Colonization of Central Europe."

Heating and Ventilating Engineers, Institution of, at the Town Hall, Scarborough. 9.30 a.m. Summer General Meeting. Mr. J. W. Cooling, "Air Heaters."

British Commonwealth League, at the Royal Society of Arts, Adelphi, W.C. 10 a.m. to 6 p.m. Conference on the Position of Women in Relation to Migration.

WEDNESDAY, JUNE 23..Geological Society, Burlington House, W. 5.30 p.m.

Philosophical Studies, British Institute of, at King's College, Strand, W.C. 5.30 p.m. "The Philosophic Basis of Hinduism." (Lecture III.).

British Commonwealth League, at the Royal Society of Arts, Adelphi, W.C. 10 a.m. to 6 p.m. Conference on the Position of Women n Relation to Migration.

THURSDAY, JUNE 24..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Royal Society, Burlington House, W. 4.30 p.m.

FRIDAY, JUNE 25..Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m.

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REGISTERED AS A NEWSPAPER.

: SOME CANTOR : AND OTHER LECTURES.

Recently delivered before the Royal Society of Arts.

(Cobb Lectures.) Certain Fundamental Problems in Photography. Three Lectures. By T. Slater Price, O.B.E., D.Sc., F.R.S. (1924.) Price 3s.

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Recent Progress in the Wool Industries. Two Lectures. By Professor Aldred F. Barker, M.Sc. (1924.) Price 1s.

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(Howard Lectures.) Motor Fuels. Three Lectures. By Professor J. S. S. Brame, F.I.C., F.C.S. (1925.) Price 1s. 6d.

Radiological Research—a History. Three Lectures. (By V. E. Pullin. (1925.) Price 2s.

The Inner Structure of Alloys. Three Lectures. By Walter Rosenhain, D.Sc., F.R.S. (1925.) Price 2s.

Copies of the above lectures can be obtained from the Secretary Royal Society of Arts.

JOURNAL OF THE ROYAL SOCIETY OF ARTS.

No. 3,840. VOL. LXXIV.

FRIDAY, JUNE 25th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. 2

FINANCIAL STATEMENT FOR 1925.

The following statement is published in this week's *Journal* in accordance with Sec. 40 of the Society's By-laws :—

INCOME AND EXPENDITURE ACCOUNT.

January 1st to December 31st, 1925.

Dr.

	£	s.	d.	£	s.	d.
To *Journal*, including Printing, Publishing and Advertisements	3,485	4	7			
„ 10 Volume Index	171	7	6			
„ Library and Bookbinding	116	3	3			
„ Medals :—						
Albert 21 10 6						
Society's 33 9 6	55	0	0			
„ Sections :—						
Dominions and Colonies 123 1 8						
Indian 182 17 3	305	18	11			
„ Cantor Lectures	118	7	6			
				4,252	1	9
„ Expenses of Examinations				10,692	3	5
„ House :—						
Rates and Taxes	393	4	8			
Insurance, Gas, Coal, Expenses and Charges incidental to Meetings	706	9	8			
Repairs	153	11	7			
				1,253	5	11
„ Office Expenses :—						
Salaries, Wages, and Pensions	3,944	2	6			
Stationery and Office Printing	458	12	7			
Advertising	3	10	0			
Postages, Parcels, and Messengers' Fares	255	15	7			
				4,662	0	8
„ Committees :—						
General Expenses				41	1	4
„ Industrial Art Committees				332	2	7
„ Repairs to John Shipley's tomb				15	0	0
„ Interest on Bank Overdraft				174	7	10
„ Balance, being Excess of Income over Expenditure transferred to Capital Account (see Balance Sheet)				154·16		3
				£21,576	19	9

Cr.

	£	s.	d.	£	s.	d.
By Subscriptions	6,254	10	6			
„ Life Compositions	731	5	0			
				6,985	15	6
„ Interest and Dividends on Society's Investments	346	15	1			
„ Ground Rents	373	11	9			
„ Interest, Dividends, and Ground Rents from Trust Funds for General Purposes	499	7	10			
Do. from Building and Endowment Funds	22	7	5			
				1,242	2	1
„ Sales, etc. :—						
Journal	261	6	10			
Do. Advertisements	750	0	0			
Cantor Lectures	6	15	0			
				1,018	1	10
„ Examination Fees and Advertisements in and Sale of Examination Papers				12,037	1	4
„ Charges for Expenses for the use of Meeting Room				219	8	0
„ Rent of Cellars				74	11	
				£21,576	19	9

TRUST INCOME AND EXPENDITURE ACCOUNTS.

Dr.

	£	s.	d.
Trueman Wood Lecture Trust—			
Interest on Investments	32	14	8
Less cost of Sir E. Rutherford's and Sir C. H. Smith's Lectures	42	0	0
Balance due to the Society	9	5	4
Balance forward	752	18	8
	£762	4	0

Cr.

	£	s.	d.	Trust Accumulations Dec. 31st. 1925 £	s.	d.
John Stock Trust—						
By Balance, January 1st, 1925	39	6	9			
„ Interest on Investments	3	10	2			
				42	16	1[illegible]
North London Exhibition Trust.—						
„ Balance, January 1st, 1925....	50	10	6			
„ Interest on Investments	6	14	10			
				57	5	4
Dr. Aldred's Trust—						
„ Balance, January 1st, 1925	59	18	5			
„ Interest on Investments	7	14	5			
				67	12	10
Thomas Howard's Trust—						
„ Balance, January 1st, 1925	77	18	8			
„ Interest on Investments	19	19	8			
	97	1[illegible]	4			
Less cost of Prof. Brame's Lectures....................	30	0	0			
				67	18	4
Mulready Trust—						
„ Balance, January 1st, 1925	38	18	1			
„ Interest on Investments	5	5	4			
				44	3	5
Dr. Swiney's Trust—						
„ Balance, January 1st, 1925	40	0	0			
„ Ground Rents (Income from)..	180	0	0			
	220	0	0			
Less Transfer to Society's Income and Expenditure a/c	140	0	0			
				80	0	0
Francis Cobb Trust—						
„ Balance, January 1st, 1925	27	3	7			
„ Interest on Investments	8	18	10			
				36	2	5
Le Neve Foster Prize Trust—						
„ Balance, January 1st, 1925	31	11	4			
„ Interest on Investments	5	16	0			
	37	7	4			
Less Prize for Essay	25	0	0			
				12	7	4
Fothergill Trust—						
„ Balance, January 1st, 1925	89	16	8			
„ Interest on Investments	13	12	5			
				103	9	1
Benjamin Shaw Trust—						
„ Balance, January 1st, 1925	13	10	2			
„ Interest on Investments	4	13	6			
				18	3	8
Cantor Trust—						
„ Interest on Investments	140	5	2			
„ Ground Rents (Income from)..	141	0	0			
	281	5	2			
Less Transfer to Society's Income and Expenditure a/c ..	281	5	2			
				—	—	—
Davis Trust—						
„ Interest on Investments	78	2	8			
Less Transfer to Society's Income & Expenditure Account	78	2	8			
				—	—	—
„ **Sir George Birdwood Memorial Trust—**						
Interest on Investments	36	15	0			
Less cost of Sir D. Prain's Lecture (including Printing)	36	15	0			
				—	—	—
Russian Embassy Prize Trust—						
„ Balance, January 1st, 1925	15	0	0			
„ Interest on Investments	5	0	0			
				20	0	0
Dr. Mann Trust—						
„ Balance, January 1st, 1925	100	8	0			
„ Interest on Investments	51	8	6			
	151	16	6			
Less Cost of Lectures	53	6	3			
				98	10	3
Owen Jones Memorial Trust—						
To Interest on Investments	15	13	4			
Less Prizes awarded	15	13	4			
				—	—	—
Thomas Gray Trust—						
„ Interest on Investments	113	14	5	113	14	5
				£762	4	0

1926—Jan. 1. By Balance brought forward £752 18 8

BALANCE SHEET, December 31st, 1925.

Dr.

	£	s.	d.	£	s.	d.
To Capital Account—						
As on January 1st, 1925 ..	74,685	9	2			
Donations *re* Building Fund	147	8	0			
Income and Expenditure Account Balance	154	16	3			
				74,987	13	5
„ Sundry Creditors				1,104	1	2
„ Bank Overdraft				5,883	14	11
„ Industrial Art Fund (Donations received and not yet expended)				689	7	0
				82,664	16	6
„ Trust Funds—						
Capital Account	21,899	7	5			
Accumulations under Trust Income and Expenditure Account	752	18	8			
				22,652	6	1
				£105,317	2	7

Cr.

	£	s.	d.	£	s.	d.
By Freehold Premises 18 and 19, John Street as on December, 31st, 1923				50,392	16	7
„ Books, Pictures, etc.......				10,000	0	0
„ Investments (see schedule)				17,481	8	5
„ Subscriptions outstanding				2,405	0	0
„ Sundry Debtors and Ground Rents outstanding....				741	16	10
„ Paid on Account of 1926 Examinations, etc.				2,306	13	4
				83,327	15	2
„ Trust Funds—						
Investments	21,899	7	5			
Ground Rents, etc.	90	0	0			
				21,989	7	5
				£105,317	2	7

We have audited the above Accounts and Balance Sheet for 1925 *with the books, accounts and vouchers relating thereto, and certify them as being in accordance therewith. We have verified the Bank Balances and investments.*

KNOX, CROPPER & Co.,
Chartered Accountants

Spencer House, South Place, E.C. 2.
18 June, 1926.

SCHEDULE OF THE SOCIETY'S INVESTMENTS.

(as valued December, 1922).

£	s.	d.		£	s.	d.
			Ground-rents (amount invested)	£10,496	2	9
£217	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	157	0	0
£500	0	0	New South Wales 4 per Cent. Stock	445	0	0
£500	0	0	Canada 3½ per Cent. Stock	430	0	0
£100	0	0	Queensland 4 per Cent. Stock	97	0	0
£530	10	1	New South Wales 5 per Cent. Stock	514	11	0
£500	0	0	Natal 4 per Cent. Stock	445	0	0
£321	15	9	Metropolitan Water Board "B" Stock	209	3	0
£6	0	0	New River Company Shares	6	0	0
£3,408	14	6	India 3½ per Cent. Stock	2,181	11	8
£500	0	0	South Australia 4 per Cent. Stock	500	0	0
£2,000	0	0	War Loan 5 per Cent..	2,000	0	0
				£17,481	8	5

TRUST FUNDS INVESTMENTS SCHEDULE.

	£	s.	d.		£	s.	d.
Alfred Davies Bequest	£1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	£1,800	0	0
Mr. Swiney's Bequest	4,477	10	0	Ground-rents (amount expended)	4,477	10	0
Mr. Cantor's Bequest	2,695	11	3	Do. do. do.	2,695	11	3
Mulready Trust	105	9	9	National 5 per cent. War Bond, 1927	109	10	1
Howard Trust	571	0	0	Metropolitan Railway 3½ per Cent. Stock	510	9	5
Owen Jones Trust	522	3	2	India 3 per cent. Stock	423	0	0
Mr. Cantor's Bequest	3,273	16	6	Do. do.			
	648	10	7	Bombay & Baroda Railway Guaranteed 3 per Cent. Stock	2,573	10	0
J. Murray and others, Building Fund	20	16	4	India 3½ per Cent. Stock	20	10	0
	38	11	0	5 per Cent. War Loan	54	18	0
Francis Cobb Trust	255	14	1	New South Wales 3½ per Cent. Stock 1930-50	250	0	0
Le Neve Foster Trust	105	11	7	3½ per Cent. War Loan	100	0	0
	42	2	1	5 do. do.	40	0	0
John Stock Trust	70	4	0	5 do. do.	100	0	0
Shaw Trust	93	12	0	5 do. do.	129	6	8
North London Exhibition Trust	134	17	0	5 do. do.	184	15	0
Fothergill Trust	272	7	6	5 do. do.	374	0	0
Aldred Trust	154	8	0	5 do. do.	210	17	6
Endowment Fund	394	7	0	5 do. do.	525	2	3
"Trueman Wood" Lecture Endowment Fund	654	15	7	National 5 per Cent. War Bonds, 1928	654	18	0
Sir George Birdwood Memorial Fund	734	19	9	5 per Cent War Loan	674	0	0
Russian Embassy Prize	100	0	0	5 do. do.	91	9	3
Mann Trust	1,028	9	2	5 do. do.	900	0	0
Thomas Gray Memorial Trust	6,498	7	9	3½ do. do. Conversion Loan	5000	0	0
					£21,899	7	5

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One-hundred-and-seventy-second Annual General Meeting, for the purpose of receiving the Council's Report and the Financial Statement for 1925, and also for the election of Officers and new Fellows, will be held, in accordance with the By-laws, on Wednesday, June 30th, at 4 p.m.

(By Order of the Council)

GEORGE KENNETH MENZIES,

Secretary.

SOCIETY'S ALBERT MEDAL.

The Albert Medal of the Society for the current year has been awarded by the Council, with the approval of HIS ROYAL HIGHNESS THE PRESIDENT, to PROFESSOR PAUL SABATIER, Member of the Institute of France, Foreign Member of the Royal Society, Davy Medallist, Nobel Prizeman, in recognition of his distinguished work in science and of the eminent services to industry rendered by his renowned researches in Physics and Chemistry which laid the foundation of important industrial processes.

PROCEEDINGS OF THE SOCIETY,

EIGHTEENTH ORDINARY MEETING.

WEDNESDAY, MAY 5TH, 1926.

PROFESSOR W. H. ECCLES, D.Sc., F.R.S., in the Chair.

THE CHAIRMAN said that in introducing the Lecturer he thought he might be permitted to adopt the historical method. About 1912 wireless engineers all over the world had been greatly startled to hear that in San Francisco a Poulsen arc had been set up of extraordinary power—ten times as big as anything known hitherto in Europe, of 150 kws. instead of 15 kws. At that time the situation in Europe was that it had been definitely proved to be impossible to make a large Poulsen arc; yet there it was in San Francisco. The news then leaked out gradually that the moving spirit behind the venture was a young Australian named Elwell. But that had not been all. The news came through very soon that some wooden masts of extraordinary height had been erected in San Francisco and in Hawai. Instead of being the usual 300 ft. they were more than 600 ft. in height—again, quite unprecedented. It had come out later that both those remarkable phenomena of the new world were due to the lecturer of that evening. During the years that followed, especially the war years, the genuineness of those improvements in wireless engineering had been amply substantiated. Mr. Elwell had supplied large arcs and high masts to various Allied Governments. He might refer to the Rome station as an example. At Rome during the war Mr. Elwell had erected for the Italian Government a station containing two arcs of about 200 kws. each, and three wooden masts each more than 700 feet high, and had accomplished the work in the record time of about four months—a wonderful achievement considering the conditions which had then ruled, and the limitations of materials and labour. Even these few words would make the audience realise that the lecturer that evening would tell of things that would be well worth listening to by all those who were interested in wireless matters.

The following paper was then read:—

RADIO: ITS PAST, PRESENT AND FUTURE.

By C. F. ELWELL, B.A., M.I.E.E., F.Inst.Rad.Engrs.

This year is the thirtieth anniversary of the arrival of Senator Marconi in this country, where he received from Sir William Preece the encouragement which was so necessary to an inventor with an epoch-making idea. The early history of radio has been told so many times that it will not be repeated here. In the early days of radio imagination ran riot, and many were the predictions which have not been fulfilled. The wireless telephone was to have done away with wires. To those who have been connected with radio for twenty years or more, it is hard even to-day to realise what great services it has rendered to mankind. It is the object of this paper to show a few of the signal services which radio has already rendered and others which it may yet render in the future. The paper will not be confined to the achievements

of radio alone, because it has helped other arts, which in their turn have helped radio with its problems. For example, the debt which telephone engineers owe to radio is now being repaid by the assistance which telephone engineers are giving in the solution of the problem of commercial two-way transatlantic radio telephony. Briefly, the paper will sum up on behalf of radio engineers their past accomplishments, and speculate a little on the possibilities of future service.

In the early days of radio it could hardly have been called engineering, and there were few engineers connected with it. However, as the results obtained by these pioneers brought recognition and the necessary financial backing, many other engineers joined in the task of solving radio problems. The Great War gave radio a vigorous stimulus, because many trained minds devoted their energies to war problems which could only be solved by radio, and the capital available was practically unlimited. Many of these war developments have since been applied under peace conditions, and have contributed largely to some of the recent striking achievements.

Let us first take the purely radio achievements, and then some examples of where radio engineering principles and apparatus have been applied with benefit in other spheres of activity. You will be surprised at the variety of these applications of the work of Clerk Maxwell, Hertz, Marconi, Fleming, de Forest, and others.

Radio Telegraphy.

Thus far this is perhaps the largest field of application, and may be divided into three classes :—

(*a*) Communication over distances where wires or cables cannot be laid, as, for example, with moving ships, trains, aeroplanes, motor cars, etc.

(*b*) Communication over distances which otherwise can only be spanned by means of expensive cables, as, *e.g.*, in competition with submarine cables.

(*c*) Communication over distances which otherwise would be served by means of overhead wires or underground cables, *e.g.*, in competition with wire lines.

Naturally, radio telegraphy has no serious competition in the first class, and it is along these lines that it rendered its first and most valuable services. Because of this feature alone there are to-day about 16,500 ships equipped for the transmission and reception of radio telegrams, whether for the service of the owners, the travelling public, or the safety of the ships and the lives of all on board. To give these 16,500 ships adequate service some 1,600 land stations have been equipped, and are being maintained. This fact when considered in connection with the large number of lives which have been saved at sea, constitutes probably radio's greatest service to mankind.

The second class of communication is a natural sphere for radio because of the great expense of laying long submarine cables and their liability to in-

terruption. For a fraction of the cost of a submarine cable, a practically uninterrupted service can now be given by two radio stations, which have the added great advantage of being useful for communicating to many other points. Greater efficiency of transmission is claimed for cables because messages can be sent to the ends of the earth with the aid of a few batteries, whereas the radio engineer in the past has been compelled to use many hundreds of kilowatts to accomplish the same end. But it cannot be assumed that this condition of affairs will continue to exist much longer. With amateurs working to Australia on short waves with the expenditure of only a few watts and the development of the beam system, it may not be long before the cable companies' strongly entrenched position will be assailed. For already established economic reasons radio can give a very good commercial service more cheaply than cables and has thus rendered signal service in the reduction of the very high rates previously obtaining. From my own experience one example is enlightening. The completion of the radio stations at San Francisco and Honolulu resulted in a reduction of the ordinary message rate from 1s. 6d. to 1*s*. per word, and for the press rate from 8*d*. to 1*d*. per word. The direct result of the reduction of the press rate was an immediate increase in the quantity of world's news transmitted to Honolulu. Instead of a daily average of about 100 words, an average of about 1,500 words per diem is now transmitted. Thus does radio help to emancipate the peoples of outlying places. Another example to show that radio has proved its efficacy in this field is the admission by the President of the Western Union Cable Company in his annual report for 1924, that radio was responsible for 30 per cent. of the traffic across the Atlantic. To-day there are hundreds of radio stations built primarily for communication across stretches of water, either in competition with cables, or to avoid the necessity of laying them. The strategic value of radio to an Empire like ours is in itself enormous.

The third class of communication which roughly means competition with wire line telegraphy has resulted in the erection of many stations. Owing to the comparative cheapness of overhead wire lines and their ever-growing substitutes, underground cables, it cannot be said that radio has made such an impression in this class. But it has exerted a healthy influence in the lowering of rates. In times of storm, when wire lines are apt to be blown down, radio has rendered signal services in maintaining communications. On the whole, it can be said to have justified its existence even in this case, though the field be unfavourable to it.

Before leaving radio telegraphy, a few words might be said as to the services which radio may render in the future. In my opinion the possibilities in the first class have not been fully developed. The cost of telegrams from ship to shore and ship to ship is excessive. A reduction of rates would almost certainly lead to an increase in the use of this service, both commercially and socially. This class of communications should not be kept on the plane

of emergency telegrams only. Then again the quantity of press news transmitted daily to ships at sea is quite inadequate. The future should provide a real daily newspaper on board containing large quantities of fresh news from all parts of the world, instead of the daily newspaper, printed before the ship left port, and containing mostly items which have appeared in other newspapers weeks and weeks before. The addition of a few hundred words of press news picked up by the ship's operator does not constitute a real news service.

In the second class advances in radio communication methods and apparatus should continue to cause reductions in the cost of maintaining communications with distant countries, until the suggested penny per word within the Empire should at least be the concrete example, as far as the British Empire is concerned.

In the third class the increasing use of underground cables should tend to relieve radio, with its somewhat restricted gamut of wave lengths, for more useful service in the other two classes. It will always have its field in covering distances where wires or cables would be expensive, either due to the nature of the obstacles between, or to paucity of traffic.

Radio Telephony.

This branch of radio may in time eclipse radio telegraphy. It is subject to the same classification as given above for radio telegraphy.

In the first class we are on the threshold of wonderful developments in the form of the possibility of being able to call up ships at sea, just as we now call up any other subscriber. The possibility of employing the ordinary subscriber's apparatus to talk to ships at sea has already been proved, as witness, *e.g.* the ship to shore conversation by wire and radio over distances of 100 and 200 miles from Southampton and 400 miles from Long Island. Such relaying of wire line telephony has even been done after the speech has been transmitted 5,500 miles. This opens up enormous possibilities to the travelling public.

In the second class the advantage is with radio in that it has been possible to telephone over much greater distances by radio than over submarine cables. If this condition of affairs continues then radio will be the means of increasing the facilities for really long distance transmarine telephony. In 1915 speech was transmitted by radio from Arlington, near Washington, both to San Francisco, a distance of 2,500 miles, and to Paris, a distance of 3,300 miles. The recent transatlantic radio telephone experiments between London, via Rugby, and New York, via Long Island, a distance of 3,580 miles in all, bring home how close we are to commercial application.

In the third class radio has so helped wire line work that it may come to pass that it may itself be unnecessary in the future. Communication with places where wires would be too costly or difficult to provide will, of course, always provide a sphere of action for radio telephony.

Broadcasting.

The wonderful growth of broadcasting has been due to the fact that it fills a real want. One of the physical facts which has in some senses been a drawback to radio makes it a powerful medium for the dissemination of news, education and amusement to the millions. In addition, broadcasting has made radio theory and practice so familiar, that the development and solution of outstanding problems cannot fail to be accelerated. The amateur often solves problems years ahead of the commercial companies. From a statistical point of view this is perhaps to-day radio's greatest field of activity. It is estimated that there are five million sets in the U.S.A., and two million sets in the United Kingdom.

Miscellaneous Radio Applications.

(*a*) *Direction Finding.*

Radio direction finding apparatus on board ship, or on an aeroplane, adds greatly to the safety of the ship and all on board. Approximately 260 British ships alone have been equipped with direction finding apparatus, and 85 stations have been equipped for emitting signals of such a nature as to assist ships in locating their position, or aeroplanes in landing.

(*b*) *Beacons.*

An increasing number of radio beacons are now being installed. These beacons are a further aid to the navigation of ship and aeroplane equipped with direction finding apparatus. In time all danger points should be equipped with radio beacons with ranges sufficiently great to minimise the danger to approaching shipping.

(*c*) *Leader Cables.*

Cables laid at the bottom of entrances to harbours, such as Portsmouth and New York, can be energised and detected by radio methods and serve to guide ships safely to anchor in the densest fog. There should be an increasing use of these in the future, because they do not use any of the already crowded band of wave lengths available.

(*d*) *Echo Depth Recording.*

By means of echo depth recording systems it is now possible for a vessel equipped with a cartridge firing apparatus to ascertain the depth of the water beneath her, or of a possible obstruction. The system can be used for all depths up to 4,000 metres, and is another aid to navigation.

(*e*) *Time Signals and Weather Reports.*

Following the lead given by France many countries send by radio daily time signals controlled by famous observatories. Barometric pressures and general weather forecasts as well as positions of icebergs, derelicts, etc., are also supplied daily to mariners, and contribute to the safety of life at sea.

(f) Public Address Systems.

In large halls of which the accoustic properties are bad, and in the open air, the voice of a speaker can now be picked up by means of a microphone standing on the table or a pedestal near by, and the amplified voice currents can be reproduced by a number of loud speakers. In the case of out-door gatherings, a battery of loud speakers, each equipped with large wooden horns, can be used to talk to 100,000 people. At the last elections in the U.S.A. the President was able to speak into a microphone at Washington, and his speech was conveyed over wire lines to a large number of broadcasting stations in various parts of the country. The broadcasted speech was thus heard by probably not less than twenty million listeners.

Radio Assistance to Other Arts.

(a) Telephony over Wires and Cables.

Probably the greatest application of radio methods and apparatus in spheres outside radio engineering has been to wire line telephony. This is the fiftieth anniversary of the transmission of a complete sentence by telephone. Telephone development after 30 years had succeeded in transmitting speech over 900 miles of wire line and 90 miles of cable. Telephone engineers had searched assiduously for a telephone relay to increase the highly attenuated telephonic currents at the end of long lines, and found it when radio produced the three-electrode valve, and resultant amplifiers. We may take some credit unto our nation for the wonderful device which is the touchstone of modern development in many branches of engineering and science. In the first place the two-electrode valve was invented by Dr. J. A. Fleming, of University College, London. Then Dr. Lee de Forest invented the grid or third electrode, which has made possible most of the applications of radio mentioned in this paper. Like many epoch-making inventions, its great value was not recognised or applied immediately. The first patent on the three-electrode valve was applied for in 1906. By 1911 very few three-electrode valves were in existence. I take some pride in the fact that an Australian had the courage of his convictions which contributed largely to subsequent development and applications of the three-electrode valve. In 1911 I gave a position in the laboratory of the Federal Telegraph Co., of which I was then the founder and chief engineer, to Dr. de Forest. With firm belief in the future possibilities of the audion, by which name it was then known, I had some made up by a San Francisco vacuum apparatus manufacturer. Work in the laboratory by Dr. de Forest and other engineers of the Company resulted in the development of the three-stage amplifier so well known to you all to-day. It was immediately applied to the reception and recording of weak telegraph signals, and one taken by me to Washington was said by Dr. L. W. Austin to have an amplification factor of 120. The engineers of the Bell Telephone system realising that the long sought relay had arrived, soon purchased the patent rights for wire line

telegraphy and telephony. Their engineers proceeded to develop and apply the telephone repeater for which they had so long waited. By 1913 telephonic conversations were carried on between New York and Salt Lake City, a distance of 2,600 miles, and between Boston and Washington over 455 miles of underground cable. In 1915 transcontinental telephony was an established fact over 3,650 miles of line between Boston and San Francisco. In 1921 conversation was carried out over 115 miles of deep sea cable from Havana, Cuba, to Key West, Florida. Later a conversation was carried out between Havana and Catalina Island off the coast of California, a distance of 5,500 miles, involving the before-mentioned 115 miles of submarine cable, overhead and underground lines, and a radio telephone. Telephony over 621 miles of cable had also become commercial. Concurrently the three-electrode valve has been employed to increase telephone facilities in Europe, culminating in the recent telephone conversations between London and Berlin, involving 91 miles of submarine cable, and 709 miles of wire lines. During the war there was a telephonic circuit from German G.H.Q. in France to Constantinople.

Radio has also made it possible to telephone over existing electric light wires and transmission lines. There is a field here for considerable development, which will not in any way tend to overcrowd the ether, to judge from experience in the U.S.A., Italy and Germany.

(*b*) *Telegraphy over Wires and Cables.*

Radio has made it possible to send by means of what are known as carrier currents, several messages simultaneously over a single pair of wires. It has also made a number of circuits available on wires already in use for telephony, and thus greatly increased telegraph facilities.

Another aspect of the use of the three-electrode valve should not be overlooked. Whereas conductors weighing 150 lbs. per mile were necessary before the advent of thermionic repeaters, better speech is now possible over much greater distances with conductors weighing only 20 to 40 lbs. to the mile. Considering the millions of miles of telephone circuits now in existence, the value of the copper saved must be a very large amount indeed.

(*c*) *Transmission of Pictures.*

Many inventors have worked for years on the problem of transmission of pictures over wire lines. Radio has now helped to solve the problem so that to-day a commercial service for the transmission of pictures developed by the engineers of the Bell Telephone Laboratories, exists between New York and San Francisco, a distance of 3,500 miles. Quite recently pictures of the Prince of Wales and Queen Alexandra, and even a cheque which was duly honoured within an hour of receipt, were sent by radio across the Atlantic. The transmission of pictures of events in the capital of the Empire to all the Dominions and Colonies will, no doubt, be an application of radio in the not very distant future.

(*d*) *Talking Motion Pictures.*

Conceived in the same laboratory, where means for accomplishing it were cradled, perfectly synchronised talking motion pictures are now an established fact, and are being shown commercially in the U.S.A. and England.

(*e*) *Precipitation of Dust.*

The two-electrode valve of Dr. Fleming has been directly applied to the problem of the precipitation of dust. This may be required because of valuable contents or noxious effects on health or vegetation. The process could be used for precipitating coal smoke, and might still be a solution to the problem of dissipating or preventing the formation of the bank of smoke-charged particles which cut off the valuable rays from the sun in densely populated areas.

(*f*) *Electric Furnaces.*

Radio has contributed to advances in metallurgy because of the applications of high frequencies, and methods of generating them, to electric furnaces for the reduction of refractory ores. The method gives high efficiency and a great measure of temperature control. Tempering and annealing, melting of glass and enamels and driving off of occluded gases in metals used in the construction of three-electrode valves are some of the applications.

(*g*) *Motion Pictures by Radio.*

The transmission of pictures by wires and radio is an accomplished fact. When a picture the size of that employed on a cinema film, *i.e.*, ¾in. x 1in., can be transmitted in sufficient detail in, say, 1/20 second, then we shall have motion pictures by radio, if we have the necessary apparatus, or go to a hall where it has been installed. This seems a possibility in a nearer future than television with sufficient detail. Immediately the problem of motion pictures by radio has been solved, the talking motion picture by radio will follow immediately, as the transmission of speech or music by radio and the synchronising of the two should not present any serious difficulties.

(*h*) *Television.*

Popular imagination has been stirred by the possibility of seeing what is happening at a distance, if not in colour, at least in monochrome. Many inventors have worked on the problem for a great many years, and most of the prophecies are rather overdue. Two inventors have recently announced their ability to send pictures in 1/10 second, which, with the aid of persistence of vision, should enable the picture on the screen to be seen as a continuous one. Here in London Mr. J. L. Baird has made notable progress in the last few months. Many difficult problems remain to be solved, and whether actual transmission will be by wire or radio, the latter art will be bound to play an important part.

(*i*) *Sound Recording.*

The improvement in the quality of the reproduction of speech and music recorded upon gramophones has been very noticeable, especially quite recently. The faithful reproduction of sound now obtainable is due to a change from mechanical methods of sound recording to electrical methods involving the combination of sensitive microphones and amplifiers. The artists and musicians now have more latitude and can sing and play more naturally. Again, the sound can be reproduced from a record by substituting an electro-magnetic system for the usual sound box. The small currents thus generated can be amplified to the desired volume, thus permitting volume regulation to suit circumstances. The Bell telephone engineers have been in the forefront of this application of telephone and radio apparatus.

(*j*) *Miscellaneous.*

Radio methods have been applied to such varied problems as those of assisting the deaf to hear, the blind to see, detection of thieves, location of buried minerals and metallic objects, fog warnings, measurement of temperature, facilitating the growth of plants, surgical knife for the treatment of cancer, detection of icebergs, wrecks and submarines, under-water telephony, etc.

Future Problems.

Among the problems open to the radio engineer for solution are the following :

Prevention of collisions at sea. Several practical schemes are now being worked upon by inventors, and a solution would fill a real want, especially if the apparatus will also detect non-metallic objects, such as icebergs, at a reasonable distance.

A practical method for the collection and transformation of the enormous solar energy which comes to the earth in the form of ether waves would help to solve our coal and oil problems of the future.

We are all familiar with examples of what we call telepathy. Is it not possible that the human body is a generator and/or receiver of ether waves of radio wave length ? We know that it is already able to detect heat and light waves. Telepathy may only be examples of correct tuning of one person's receptive sense to another person's transmittive sense. If investigation should give us the key to this problem, then communication would be easy indeed. At the same time it might have its inconveniences. A scientist predicted quite a number of years ago that the time would come when one could take an instrument the size of one's watch from one's pocket and speak to a friend, even if he might be away in the Himalaya Mountains. If he did not reply one was to assume that he was dead. It is also extremely likely that animals, birds, and insects are generators and receivers of ether waves. It is just possible that what we call instinct is the ability to receive waves transmitted by other animals, birds or insects. The homing instinct of pigeons is well

known, but an experiment made at a Spanish radio station is not without interest. A number of pigeons were released while the station was transmitting, and the pigeons flew around, and were unable to pick out their direction, evidently quite upset by the ether disturbances, which may in turn have upset their own ability to detect.

Many ingenious applications of photo-electric cells and amplifiers are being constantly made. One, for example, has for its aim the detection of forest fires. A cable is strung between two points in a mountainous and heavily timbered region. On this a car equipped with a searchlight travels back and forth. The beam of the searchlight is constantly focussed upon a photo-electric cell mounted upon a platform of the forest fire lookout tower. If the beam should pass through smoke the beam of light would be dimmed and the photo-electric cell would bring an alarm into action. Other applications involving light sensitive cells are the determination of the turbidity of liquids; recording of light and sunshine; measurement of the light from stars; sorting of cigars into claro, colorado, etc.

A number of purely radio problems yet remain to be satisfactorily solved. Among these are the fading problems, the reason for the difference in the strength of day and night signals, the cause of the "skipped distance" when short waves are used, and other allied phenomena, the mechanism of transmission, especially of ultra short waves, the narrowing of the angle subtended in beam transmission, more perfect automatic compass and a more reliable automatic apparatus for giving a warning immediately an "S.O.S." signal has been received.

CONCLUSION.

You will, no doubt, readily admit that radio has rendered valuable services both directly and indirectly, and one must not overlook the fact that other arts and sciences have rendered great services to radio. For example, radio assisted submarine signalling, and submarine signalling stimulated work in acoustics, the results of which are now being applied to radio telephone problems, thus to some extent repaying the debt to radio. Other branches of the communication art have assisted radio. Radio assisted telephony, and now telephony assists radio to solve its problems, and recent spectacular radio telephony achievements would not have been possible but for the help of telephone engineers.

In order that progress may continue serious amateur investigators should be accorded liberal treatment. The ability of the young generation to correspond with one another may do as much good as the League of Nations to promote understanding between peoples which may in future generations prevent war. If radio should add this highly desired result to its list of achievements, then radio engineers will indeed have deserved well of the world.

DISCUSSION.

THE HON. SIR CHARLES A. PARSONS, K.C.B., F.R.S., thought that one of the most important uses of wireless was on board ship. Recently, while crossing the Atlantic during very violent storms, the location of three derelict ships had been conveyed to the captain of the vessel on which he was, with the result that it had been possible to avoid the derelicts. The number of lives which had been saved directly and indirectly by the use of radio at sea must be enormous. He supposed that the coal ships which had just been recalled owing to the strike had been so recalled by radio, which also proved the value of radio in such emergencies. The possibilities of radio were very great, and it was almost impossible to forecast the wonderful developments which would come about in the future.

MR. R. H. RANGER (Engineer of the Radio Corporation in Great Britain and in charge of picture transmission across the Atlantic) mentioned the fact that as a result of the strike the demand for picture transmission from this country to the United States had been such that his Corporation had not been able to cope with it. The demand for pictures, in fact, had been more than the demand for news. That was an interesting development in radio, and it was something which his Corporation had not contemplated. It showed, also, how closer and closer together the world was getting. The world really was nothing but a small room. He had been informed by a Marconi engineer that a signal sent from a beam station went round the earth, and radio engineers were bothered because it came back and echoed eight times. In other words, we were in a small room and the echoes from the walls disturbed us.

Radio had an immense number of potential possibilities which had not yet come to be realised, and it was interesting to see how what was done in one line was of assistance in other lines, and how the benefits of one were reflected in another. For example, the gyroscopic compass had been tremendously helped by radio. The two working in conjunction had made possible commercial navigation in and out of San Francisco, with its fogs. Then in aeroplane work, if one wanted to find out how high one was in a fog, one had simply to drop the radio transmitter from the aeroplane, put the headphones on, and listen. When one heard the transmitter stop one knew what had happened.

He desired to express his appreciation of Mr. Elwell's valuable paper.

MR. J. E. TAYLOR said that congratulations were also due to Mr. Elwell for the very concise recapitulation of the past, present and future of radio telegraphy and radio telephony. He had first met Mr. Elwell at San Francisco in September, 1912, and he had then had a real " eye-opener " when Mr. Elwell had shown him the first amplifying valve in the laboratory there and had demonstrated its properties. Certainly he had not anticipated at that time that there was any possibility of a telephonic amplifier or radio frequency amplifier inherent in the vacuum tube valve, and, having had some practical experience of wireless telegraphy, he had at once appreciated the great future that lay before that amplifying valve. To his mind there was still some haziness as to the actual progress of events which had led up to the valve—both the two-electrode valve and the three-electrode valve. He thought there was room for a little more to be written on that subject yet, although he knew it was a very delicate point to touch upon, and it had been a matter of litigation ; but undoubtedly several people did share in the merit of having led up to the present three-electrode amplifying valve. Among them was one whom he had not heard Mr. Elwell refer to ; he thought the name was the Lieben-Reisz—a German invention which had come out close on the heels of the de Forest three-electrode valve.

He could only hope that some of the predictions which the author had made as to the future of radio telegraphy and radio telephony might come true, and, also, other applications. He himself was certainly a great believer in the possibilities of high frequency electrical engineering. It had opened out an entirely new field, containing many developments yet ahead of wireless engineers, of which they had no notion at present.

DR. RUSHTON PARKER asked whether it was possible to take soundings by means of radio while a ship was going at ordinary speed. He did not mean 20 knots an hour, but would it be possible for a ship travelling at, say, six or eight knots an hour to take soundings all the time and continuously? If so, it would be an exceedingly important matter, considering that the depth of the ocean was said to change very often and in different places—for instance, owing to volcanic action taking place at the bottom of the sea. If continuous soundings could be taken it could be seen whether the soundings which had been taken 30 or 40 years ago were still correct or not.

THE SECRETARY said that as one who had just gone through a very severe course of spring cleaning, he thought radio possibly might have some practical application in the home in that respect, and he would be glad to hear something more from the author about such a possibility, either on a large or small scale.

A MEMBER OF THE AUDIENCE said that towards the end of the paper mention had been made of a new automatic compass. Could any further information be given on that at the present juncture?

LIEUT.-COL. H. P. T. LEFROY said that in Mr. Elwell's very complete summary of the subject he had not mentioned anything about collisions in the air. Personally he considered that a more important subject to consider than collisions at sea. In the air the cathode ray was the only direction-indicator that would give an instantaneous indication of danger. Sir Charles Parsons had said that one of the most important uses of radio was at sea, but personally he thought that its most important use was in the air. It was comparatively easy to navigate on the sea; there was not anything like the speed of drift which there was in the air. The speed of drift in the air was such that there would not have been reliable navigation of aircraft without wireless.

The result of radio research on the knowledge of the upper atmosphere and of lightning was of considerable importance, and our knowledge of these things had been considerably increased lately by radio research work.

THE CHAIRMAN, in closing the discussion, said the paper dealt with the past, present and future of radio telegraphy. It was a side of a bigger subject—high frequency engineering—which went into all branches of physics, and upon which, therefore, all branches of phsyics and all applications of physics reacted. It was marvellous, really, to think of the number of physical principles which had been applied in wireless telegraphy. Even to understand the crystal detector required a deep knowledge of physics, and the magnetic detector went into a branch of magnetism which was quite obscure. The coherer was a mystery still in some of its aspects, and electrolytic detectors rested on chemistry and electrolysis. Then there was the audion which was an application of the electron theory. Before the audion came, people had scarcely become familiarised with the name " electron." Then, again, wireless involved the study of the physics

of the upper atmosphere, of the ionisation of gases, and of the ether itself in the Clerk Maxwell equations. Not only that, but remembering that some denied that there was an ether, and that so many supported the modern Einstein theory, it had to be said that radio telegraphy or high frequency engineering might be affected by the theory of relativity and by the connections between gravity and electricity in the time to come. So that he expected wireless telegraphy to be acted upon by, and to react upon, all classes of applied physics both in the present and future. Curiously enough, not only was it ubiquitous in physics, but it was becoming ubiquitous in another sense—in a public sense. Most of the country to-day was relying upon broadcast news for information about the strike, and one need not stretch one's imagination too far to imagine that the whole Empire might some day be broadcast to just as easily as Great Britain was broadcast to to-day—if he might use such an abominable verb as "broadcast to!" Then, after the Empire, no doubt the whole world would be merged together socially by this new influence.

MR. ELWELL, in reply, referred to Mr. Taylor's remarks, in the course of which he mentioned that he had had a few surprises when he had visited San Francisco. The Western parts of the United States and California had been supposed in earlier days to have been so far away from Europe that it had been generally thought, at any rate in those days, that nothing much could be done in those wild regions; but so much electrical work had been done in California—electrical power transmission work—that at present there were to be found there the largest plants and highest voltages that were being used anywhere. At the University at which he attended they now had a four-mile transmission line which they were working experimentally at half a million volts in preparation for the future. They were also cradling many other things in radio, but being so far away, and not having very much in the way of a Press to chronicle their proceedings, he was afraid that some of them did not receive all the credit they deserved.

A question had been asked about the dust raised in spring cleaning. From an energy point of view it would take an enormous amount of power to put up a plant to bring down all the soot over London. He had had in mind a domestic apparatus, which, installed in one's home chimneys, would prevent the soot from being drawn out into the atmosphere. The time might come when one could buy an apparatus which could be installed in the chimneys, and which would take a few watts per month, which would precipitate particles and stop them from being thrown out into the atmosphere.

With regard to taking soundings continuously, he was afraid the noise of the boat would be a difficulty. He was not familiar with the actual working of the particular apparatus, although he understood the principle. He believed the boat would have to stop in order that the signals could be listened to. The time might come when it could be done continuously.

Colonel Lefroy had raised the point about the value of preventing collisions in the air. The apparatus which would prevent or help to prevent collisions at sea would no doubt be useful in preventing collisions in the air.

CORRESPONDENCE.

HORSE AND MOTOR TRANSPORT.

I was in America studying, amongst other things, many of the questions raised by Mr. Paterson in his interesting paper; otherwise I should have been glad of an opportunity of taking part in the discussion and should have enlarged on his sub-head 9 on the sphere of the electric car.

After what I have learned on the other side and added to the experience already gained in the use of this class of vehicle on this side, I feel more than ever convinced that it is the electric vehicle that will supersede the horse in urban and suburban traffic, especially for the delivery of light goods from door to door and as the one and only satisfactory method of working the various forms of scavenger vehicles.

On this last point the experience of the cities of Sheffield and Birmingham and some of the Northern parts of London shows how much has already been done and how promising is its future for further development.

Although so much has been done by the large firms who have already purchased fleets of these vehicles, what is now required is an organisation for facilitating the use of these vehicles by the smaller class of users by starting an organisation for hiring them out, or supplying them on deferred payments, combined with a well-placed set of charging stations. When the electrical vehicle comes along in large numbers and the charging of accumulators can be carried on and give a night load to our London power stations, it will greatly reduce the cost of electricity all round. The extended use of this vehicle therefore interests everyone who at present uses electrical energy, whether for lighting, heating or cooking.

Yours faithfully,

R. E. CROMPTON.

BELGIAN FLOATING SAMPLE FAIR.

The Commercial Secretary at Brussels reports that the training ship *L'Avenir* was last year made the means of the first attempt at propaganda by means of a floating sample fair and Florida was chosen as the destination. The samples were mainly of building materials, such as asbestos-cement tiles, bricks and tiles of all sorts. The result was encouraging, and a further fair was organised later in the year, the destination being Australia. For this cruise the samples are mostly luxury articles, such as lace, linen, carpets, artificial flowers and brass goods. There are some 200 firms represented.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JUNE 28..Roman Studies, Society for the Promotion of, at Burlington House, Piccadilly, W. 4.30 p.m. Dr. George Macdonald, "Fragments of Imperial Statues found in Britain."

FRIDAY, JULY 2..Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Mr. J. A. Steers, "Orford Ness: a Study in Coastal Physiography." Messrs. L. Richardson and W. F. Fleet, "On Sandstones with Breccias below the Trias in South Warwickshire." Dr. George Slater, "Glacial Tectonics as reflected in Disturbed Drift Deposits: Part I.—Preliminary Considerations."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

THURSDAY, JULY 8TH, at 4 p.m. (Special Meeting.) FRANK HODGES, Secretary, International Miners' Federation, "The Economics of the Coal Industry." SIR RICHARD REDMAYNE, K.C.B., late H.M. Chief Inspector of Mines, will preside.

Tea will be served in the Library from 3.30 p.m.

COUNCIL.

A meeting of the Council was held on Monday, June 21st. Present:—Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Sir Edward A. Gait, K.C.S.I., C.I.E.; Sir Robert Abbott Hadfield, Bt., D.Sc., F.R.S.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Charles C. McLeod, Bt.; Sir Philip Magnus, Bt.; Mr. Carmichael Thomas; Professor J. M. Thomson, F.R.S.; Dr. J. Augustus Voelcker, M.A., Ph.D.; and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary) and Mr. W. Perry, B.A. (Assistant-Secretary).

A letter from the President was read, signifying His Royal Highness's approval of the award of the Society's Albert Medal for the current year to Professor Paul Sabatier, Member of the Institute of France, Foreign Member of the Royal Society, Davy Medallist, Nobel Prizeman, and the terms of the award were settled.

The balloting list for the new Council was completed.

The draft report of the Council for the year 1925-6 was considered, amended and approved for submission at the Annual General Meeting.

A report from the Thomas Gray Memorial Trust Committee, recommending the offer of prizes for students in Navigation at eight nautical schools, was approved.

Judges of the essays submitted for the Fothergill Prize of £100 were appointed.

Papers and courses of lectures for session 1926-7 were considered.

Other formal and financial business was transacted.

ANNUAL GENERAL MEETING.

WEDNESDAY, JUNE 30TH, 1926. SIR THOMAS HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the chair. The one-hundred-and-seventy-second Annual General Meeting of the Society was held for the purpose of receiving the Council's Report and the Financial Statement for 1925, and also for the Election of Officers and new Fellows.

A full report of the Meeting will be published in the next issue of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, MAY 7th, 1926.

The RIGHT HON. LORD HARDINGE OF PENSHURST, K.G., P.C., G.C.B. G.C.S.I., G.C.M.G., G.C.I.E., G.C.V.O., I.S.O., in the Chair.

THE CHAIRMAN said that he had much pleasure in introducing to the Society Mr. Herbert Baker, an Associate of the Royal Academy and a Fellow of the Royal Institute of British Architects, who had kindly consented to read a Paper on new Delhi. Mr. Baker was joint collaborator with Sir Edwin Lutyens in his architectural creation of the new capital of India. He (the speaker) had evidently been asked to take the Chair on that occasion—which he felt to be a great honour—because, just as he was chiefly responsible for the transfer of the capital from Calcutta to Delhi, he was also in fact, as Viceroy, entirely responsible for the selection of Mr. Baker as one of the joint architects. He had often heard of the splendid Government buildings designed and built by Mr. Baker at Pretoria, and as soon as the question arose of building a new capital at Delhi he obtained photographs of the buildings in question. He was so much impressed by their dignity, architectural beauty, and general symmetry that he decided at once that the Government of India should endeavour to secure Mr. Baker's services as architect, and they were fortunate enough to succeed in doing so. He hardly needed to say that the selection had been more than justified, and although the Secretariat buildings were only thirty feet high when the speaker left India in 1916, it was quite easy even then to realise from the designs and from what had actually been built by Mr. Baker that in the end two magnificent blocks of Government offices would be erected worthy of India and to the credit of the architect. There were just two points which he would like to emphasize in connection with Mr. Baker. These were, first, that Mr. Baker had a

genius for interpreting local sentiment in his buildings, which in the speaker's opinion was absolutely essential in a country like India, and secondly, he had, from the speaker's own personal experience, a characteristic rare in an architect, namely, that of adhering to his estimates.

The following paper was then read :—

THE NEW DELHI.

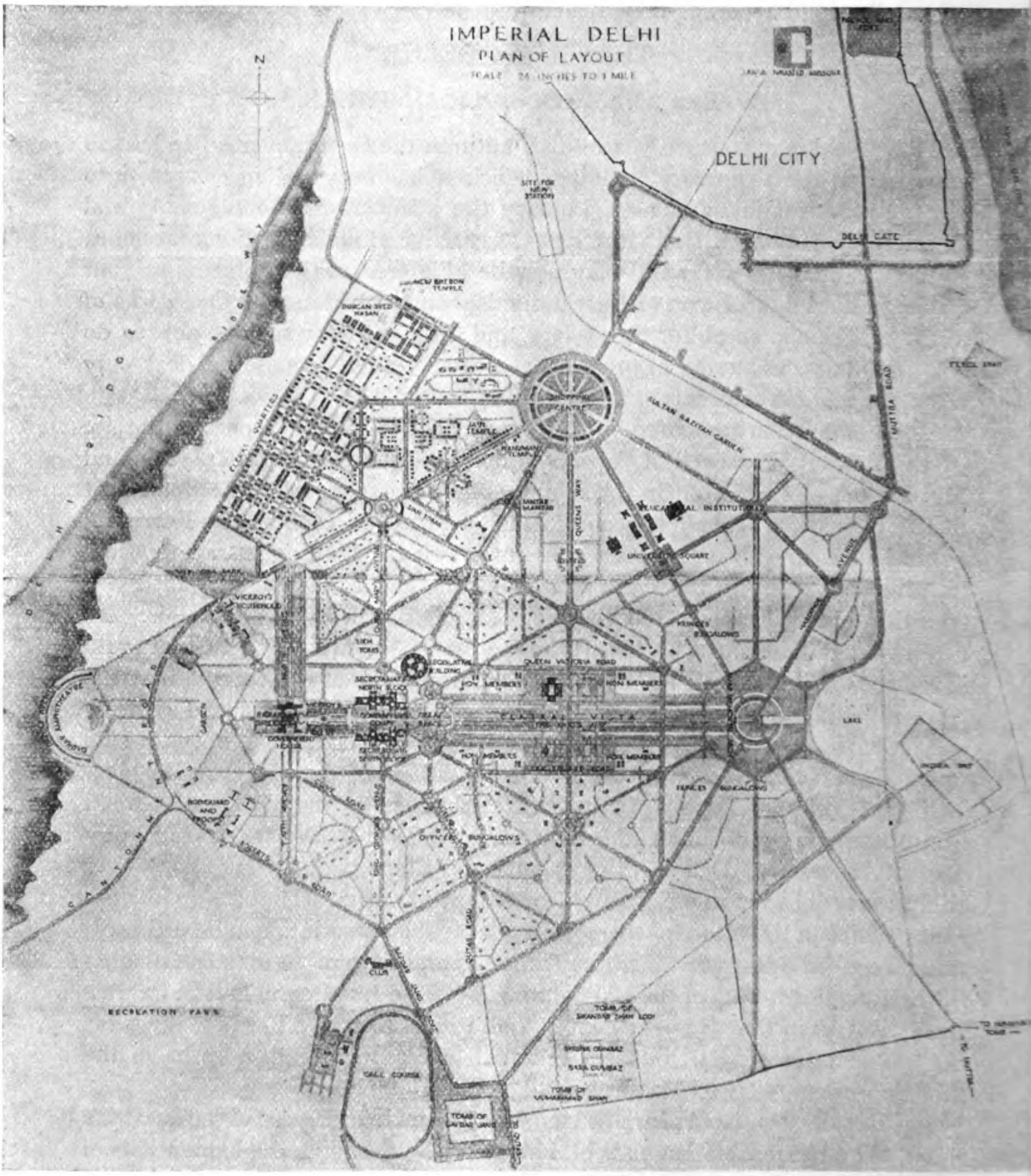
By HERBERT BAKER, A.R.A., F.R.I.B.A.

New Delhi is in its 14th year. This autumn the Government of India will move from the temporary buildings which it has occupied since 1912, into the new Secretariat, and next January the members of the Assembly and Council of State will sit in the new Legislative Buildings. Some account, therefore, of the new Capital may now be of interest to the members of your Society, but I address you with great diffidence and reluctance, as the works of architects should speak for themselves, and these will very soon be able to do so. I am besides but one of other collaborators. So I propose to deal only with the more general intent and aspect of the subject.

The Commission appointed by the Government of India to report on the site of the new city consisted of Capt. Swinton, Mr., now Sir Edwin Lutyens, and Mr. Brodie. It went out in the summer of 1912, experiencing the worst heat of the Plains, and again in the cool weather of 1912-13. I followed in February, to find a controversy on two rival sites in full swing. The Commission reported in favour of a site to the south of the existing Delhi between its walled city founded by Shah Jehan and the many deserted cities of older Delhis. Its report urged against the northern site, the British Suburb which was naturally in every one's mind, on the unanswerable arguments of the experts that the ground ultimately required for the extension of a prosperous and growing city was fever-stricken, waterlogged and liable to occasional floods. This opinion was fully justified by the severe inundations of the whole area in 1924. But there existed a strong sentimental attachment to the old familiar Delhi on and around the northern Ridge, with its historical associations of the Mutiny and of the famous Delhi Durbars; and the Ridge with its fine views over the Jumna did seem to present architectural possibilities. The battle of science and of faith in the future of the new Capital against association and sentiment, and of a clean against a rather dirty architectural slate raged for some time, as in the longdrawn wars of the Mahabharata between Hastinapur and Indraprastha. But as in that Homeric contest Indraprastha won. For now the great central vista of New Delhi faces Indrapat, the reputed Indraprastha of the first legendary city of Delhi.

The new site consisted of arable land, much quarried outcrops of the quartzite ridge, the brickmakers' mounds of immemorial cities, and the foundations of the bazaars of Feroz-Shah's Delhi. Except for a small number of unknown

and long since desecrated graves, the tombs and mosques of relative unimportance, there was no obstruction to the free planning of an ideal city. Of this opportunity Sir Edwin Lutyens and his two colleagues on the Commission took a masterful advantage. The centre point of the lay-out is an out-crop



Lay-out of Imperial Delhi.

of the quartzite rock forming on the higher ground of the Raisina hamlet a spur at right angles to the Ridge which lies roughly parallel to the bed of the noble River Jumna, the great tributary of the sacred Ganges. I remember when the site had been settled, sitting on this rock with Mr. Herbert Fisher and Mr. Ramsay MacDonald and looking down over what was destined to be the great central avenue. We were engaged in speculating how a beautiful city could arise amidst what Lord Curzon had described, if I remember right, as "the deserted cities of dreary and disconsolate tombs" when the sun setting beneath the rainclouds formed a perfect rainbow arch over the centre of the vista that was to be, just where the great arch of the Indian War Memorial is to-day rising. This good omen then acclaimed by us has been triumphantly fulfilled, as the building of the city has proceeded without a break throughout all the dark days of the War when there was more than the usual talk about the unluckiness of Delhi and evil prophecies that the War would last as long as the new city was a-building; and since the War ended it has weathered all the post war difficulties, delays, and, most dangerous of all, the Economy Commissions.

I wonder whether too much popular significance is not given to the deserted cities of Delhi. London thrives happily enough on the ruins of British, Roman, Saxon, Norman, Gothic and, alas to an increasing extent, on Renaissance Londons. The truth may well be that in the climate of the Plains the land surrounding a city soon became denuded and desiccated, and its water contaminated. We know from the memoirs of European sojourners in the Mughal Court, the horrors of the drinking water of Delhi in the comparatively civilized 17th century. The Jumna too must have changed its course as it has done in quite recent times. And so, with an unlimited choice of site that could be defended on rock or by river, it was more natural to build on new instead of upon the old ground. And so again history has repeated itself. But surely Delhi may be counted lucky rather than unlucky in being surrounded by such a wealth of well preserved architectural relics reaching back into a memorable past.

But I confess that faith was required in those early days and one felt the sting of Lord Curzon's gloomy criticism. The "disconsolate tombs" did seem endless and haunting. I used to ride most mornings for three or four months during several years to a different building or group of buildings, and even yet I have not seen them all. And nature in that climate does little to heal the wounds of ruin; they seem for ever to gape and stare. But the Archæological Department is continuing within its financial restrictions the good work initiated by Lord Curzon and is transforming the ancient surroundings of Delhi. The Qutab, Haus Khas Feroz Shah's country palace, and the Lodi tombs are already refreshed and shaded by lawns and trees. And the garden tomb of the Mughal Governor Safdar Jang reposes, and now that sweet irrigation water has replaced the old brackish wells, that of the Emperor

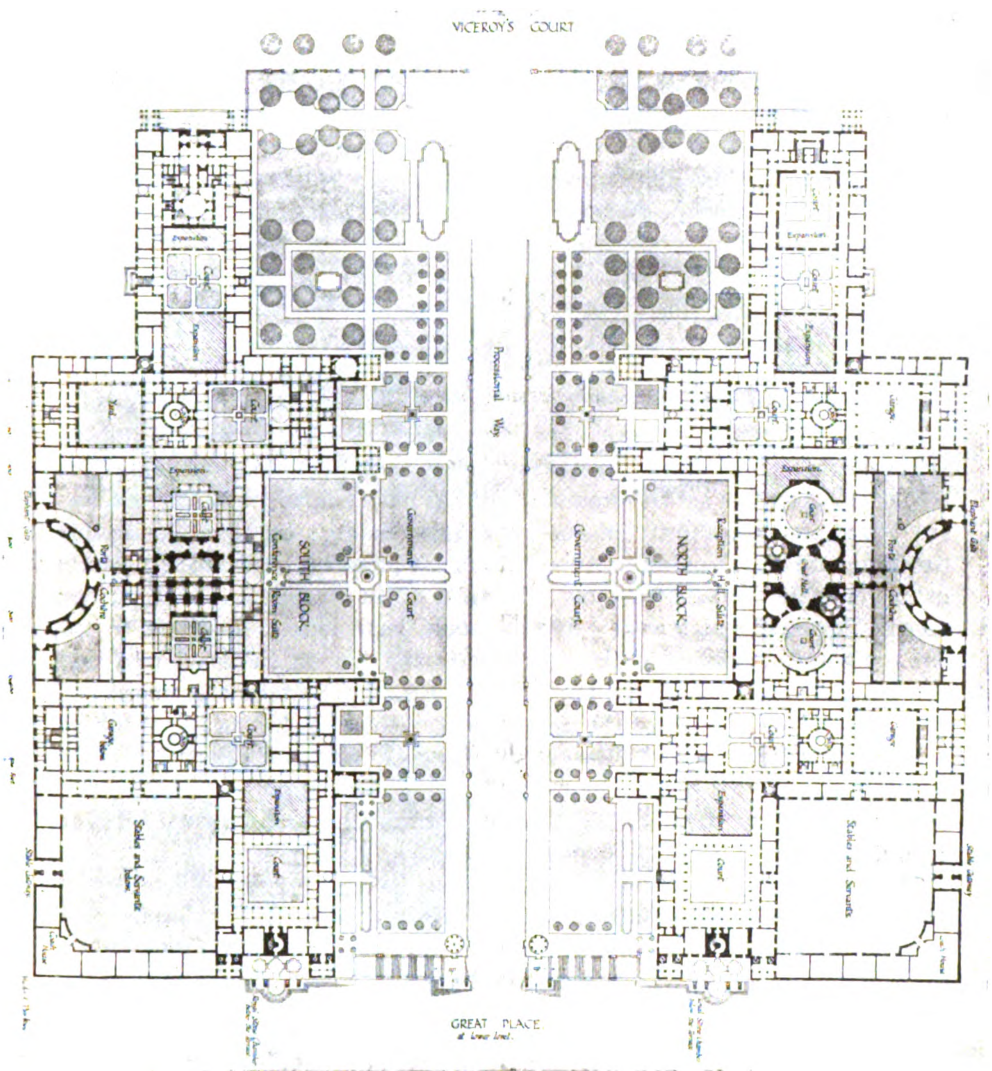
Humayun with its many attendant tombs and gateways will soon repose, amidst the beautiful gardens designed by their pious founders. All these historical buildings of Delhi in the mass may some day rival the world fame of Agra and its Taj Mahal, the beauty of which depends so much on the skill with which its designers set the architectural gem in the rich framework of its fairy water garden. One thinks of the pleasure dome of Kubla Khan

> " bright with many a sinuous rill
> " Where blossomed many an incense breathing tree."

The site of New Delhi has been called by its opponents an arid waste. It lies in fact mostly on the deep alluvial soil of the Jumna, which with the irrigation water now plentifully supplied can be extremely fertile. The disturbance of the surface soil, due to the necessary levelling and filling in of mosquito-breeding depressions dug out for the brick-earth of old Delhis, can be compensated quickly by manure and cultivation. It is true that around the central buildings which are founded upon the rock, much loosening and filling has to be done and special rock-loving trees, of which fortunately India possesses a good variety, will have to be planted.

The rock out-crop of the Raisina hamlet was chosen as the centre of a road system based on two great roads. The one leads from it to the old walled city of Indrapat, associated both with Hindu Vedic tradition and also with the Moslem Emperor Humayun, who died there. The other at an angle of 60 degrees centres on the dome and minarets of the Great Mosque, the Juma Musjid, of present Delhi. This angle of 60° gave the geometrical key to Lutyens' ingenious plan of the new City. It is a most original plan, except perhaps for the germ in L'Enfant's plan of Washington and Wren's rejected plan for London. This rock was about 50 feet high: 20 feet of it was blasted away, leaving a platform 32 feet high in front. By using the waste rock to fill the depressions, a great platform was made rising from the nearly level plain. On this platform are placed the central buildings, the Secretariat in two detached blocks, and Government House. At the time of its inception the analogy of the great base of Persepolis was pointed out. Perrot and Chipiez in their History of Art in Persia say that the object of Darius in erecting his stupendous platform was the same as that of the constructors of the great mounds in the plans of Chaldea and Assyria. It was to lift up a privileged royal enclosure in enjoyment of view and air above and city below.

The main walls of the two blocks of the Secretariat are 150 yards apart and are placed on the front of the great platform overlooking the Great Place with its great pierced stone railing, like those of the Buddhist shrines, and the 1½ mile long Maidan, avenues and water channels down to the War Memorial Arch, with the fortress walls of Indrapat and the river bed of the retreated Jumna beyond. Government House, Sir Edwin Lutyens' magnificent building, is placed on the centre line between the two Secretariats at a distance of 2,050



North and South Blocks of Secretariats, with Viceroy's Court and Processional Way.

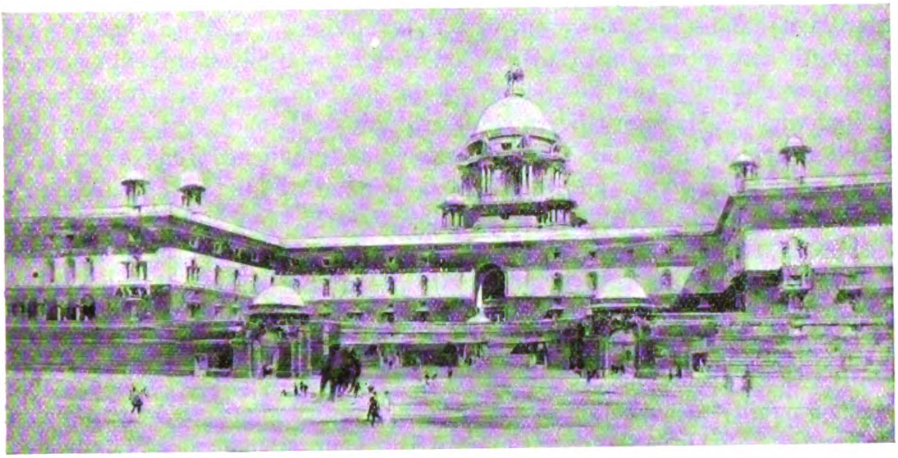
feet, or 683 yards from the dome of Government House to the centre of the Secretariats. In the centre space between—called the Viceroy's Court—is the great column given by the late Maharajah of Jaipur. There will be fountains, trees, and as much green lawn as possible between the two blocks of the Secretariats to cool the air and relieve the eye against the red stone of the lower walls. The great steps and portico of the Viceroy's State Entrance face and command the view eastwards past the column and through the

columned pavilions and between their two domes of the Secretariat. Wide Maidans and avenues lead away from the south and north elevations. Behind to the west lie the private garden and the park as far as the Ridge. Into the rock of the Ridge at this point it was designed to quarry and build a semicircular amphitheatre half a mile in diameter to take the place of the famous amphitheatres of the Delhi Durbars, which were built of perishable earth on the remote plains on the other side of the city, but no headway has been made with this amphitheatre, which in its position on the Ridge and on the axis of Government House, the Secretariats and the central vista, and in its relation to the military cantonments on the one side and to the existing city on the other, might in future royal Durbars have formed a stage for pageants unrivalled in any ancient or modern city.

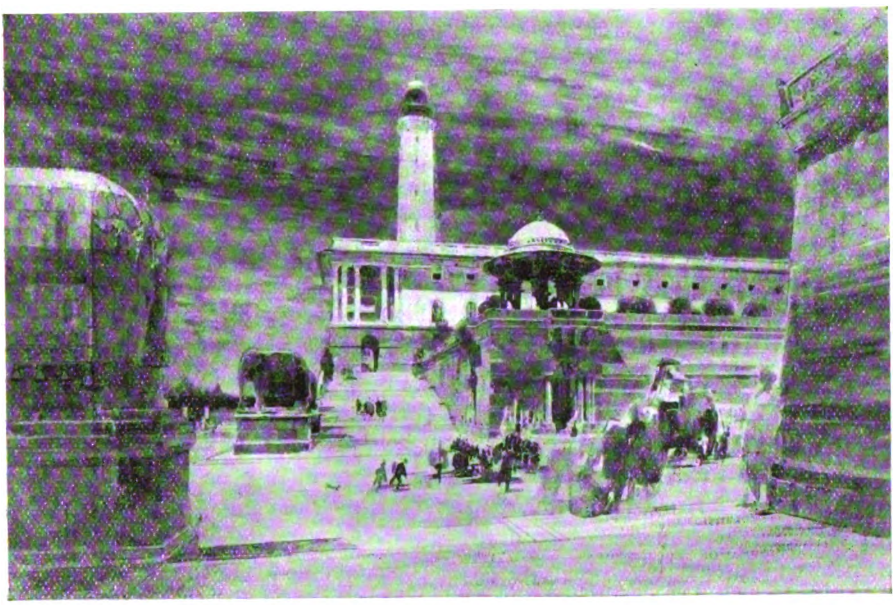
The position of the Secretariat Buildings on the same exalted platform as Government House above the level of the rest of the city, has provoked criticism. It is said that the home of the Viceroy should have been aloft and aloof from that of the officers of his Government and thus more emphatically have expressed the supreme authority of the great Lord Sahib. On that assumption Government House would have stood in solitary grandeur on the rock platform in sole enjoyment of the view over the trees of the surrounding battlements, domes, minarets and towers. And it would have looked down on to the flat roofs and chimneys of the Secretariats and not on the level past and through the columns of its porticoes. From the Secretariats, moreover, the Ministers and officers of the Government, instead of sharing this inspiring view, would when the trees grew up have seen nothing above them. For the new city before very long will appear almost as a forest city, the avenues of tall trees in every street hiding the one-storied bungalows, and all but the greater buildings.

This criticism is natural enough and raises an interesting problem in the architectural expression of the facts and ideals of governance. I remember on my first voyage to India reading this eloquent statement of what the Government of India stood for, in an article in The Round Table entitled " The English in India."

> " So long as the consciousness of civilised man recognises government as the noblest task of the race, so long by administering India is our pride of place unquestioned. No nation in modern times has done the same or can aspire to do it . . . . Thothmes and Sennacherib, Alexander and Napoleon never did the like. Only Rome in her greatest days did what England has been doing. We honour Rome, after two thousand years, for her genius for law and order and administration ; we kindle to her poet's boast,
>
> ' Haec est in gremium captos quæ sola recepit,'
>
> and yet with how much greater right can we make it ours ? When the future annals of the world are written the achievement will rank higher than the broadest-minded decrees of the Senate or the most generous edicts of the Cæsars."



One of the Secretariat Blocks.



The Approach to the Secretariats.

Well, that was the idea which we architects within our limitations tried to express on the great red-stone platform, and I venture to assert that Lord Hardinge and his Government and advisers had a high and prophetic conception when they decided to give the architectural expression of a common dignity and distinction to the instrument of Government as a united whole. May not Governments, as individuals may do, rise to the distinction given to their office? The creation of that influence is one of the higher missions of architecture, and that it is possible must be the faith of architects. If in the future this faith is in the least justified the founders and designers of new Delhi, though they may not live to know it, will not by future generations be "taxed with vain expense" or "with ill matched aims," albeit labouring, if not for "a scanty," yet for a modest band of Government officials only.

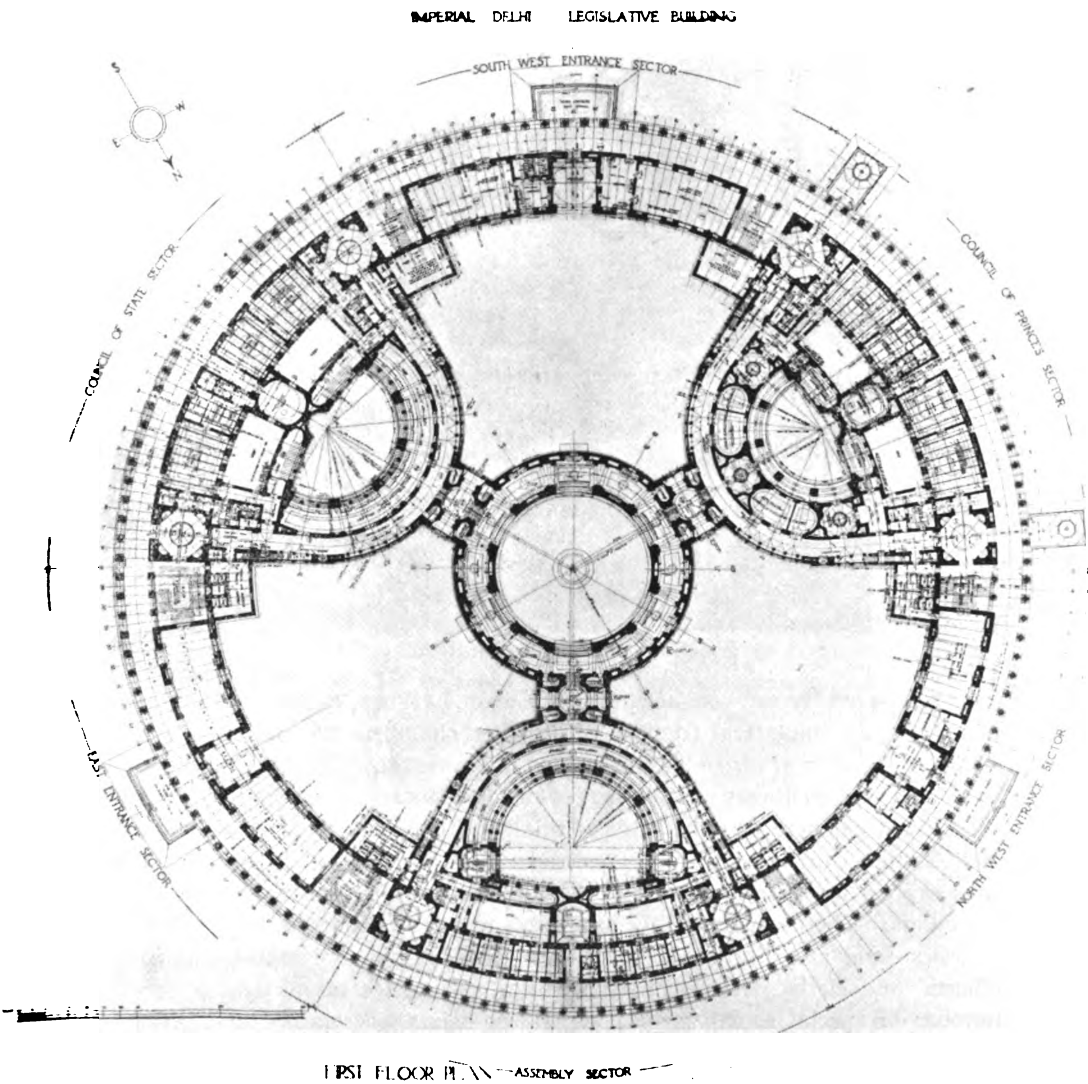
The Secretariat's three-story building gives accommodation to all the administrative departments of the Government of India. On the first floor, the "piano nobile," are placed the offices of the Hon. Members and the principal Secretaries. Each of the rooms allocated to Hon. Members and Committees has a distinctive colonnade and pavilion 52 feet above the level of the plain and through the white stone columns a wide and inspiring prospect beyond.

Otherwise, in addition to the innumerable offices the only special features in the building are a high domed entrance hall in the north block and in the south a general Conference Room surrounded by libraries and reception rooms, where the Government of India can entertain on its own behalf. Below the ground floor where the solid rock does not abut on the retaining wall of the great platform are record and storage rooms. In each block in the front of the platforms at the lower level under the Towers which face down the great avenue and water channels of the central vista, are vaulted chambers, in which are enshrined the foundation stones laid by their Majesties in 1917. The King's stone is in the South and the Queen's stone in the North Block. Over the stones are the Royal Insignia in bronze and above, cut into the stone vault, their Majesties' Coats of Arms. From the Royal Stones will spring the small fountains which feed the larger fountains and the long water channels of the Central Avenues.

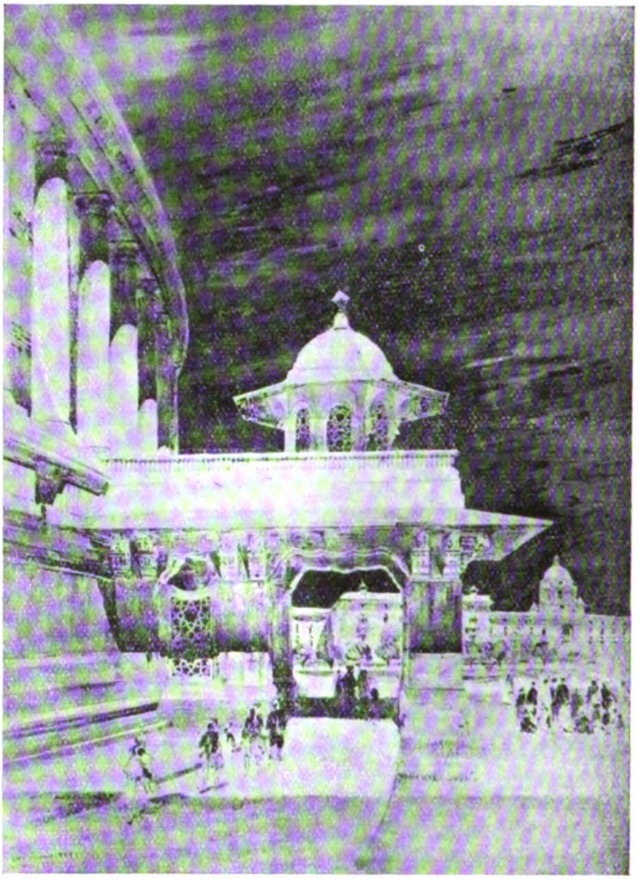
The criticism that the Legislative Buildings are placed in a position of inferiority to that of the Secretariats on the Acropolis may have some justification. This building was the offspring of the new Constitution created under the Act of 1919 and so it was conceived after the foundations and basements of the Secretariat were born. The small Legislative Assembly of the Morley-Minto Constitution, as it existed in 1913, was to have been placed in a wing of Government House. There was no room on the raised Platform for the much larger building now required. The best remaining site was chosen, as near as possible to the Secretariat for the convenience of the Hon. Members and Secretaries, who sit as members of the two Chambers. As the present Assembly Chamber is actually located in the temporary Secretariat, there will at

first be some complaint of the separation of the two buildings, but I understand that there are compensating advantages in a reasonable distance between Ministers and officers and their files, and between legislators and the offices of the Secretariat.

The Legislative building consists of three chambers, the Legislative Assembly, the Council of State and the Council of Princes. The building is of a circular



First Floor Plan of Legislative Building.



Prince's Porch, Legislative Building.

form suggested by my collaborator, Sir Edwin Lutyens, as being best suited to its site, an equilateral triangle. The three chambers are spaced at equal angles round a great central dome, 90 feet in diameter, which will be generally used as a common library for Members of all three Houses. On special occasions the Viceroy can here assemble any two or all the three Chambers and so address or hold high Durbar with the representatives of all India. The building will thus express the essential unity of the three estates represented by the three Chambers. There are also all the appurtenances of a Parliament House, public galleries—and also Purdah galleries—the three Presidents' rooms and their officers' and clerks' reading, writing, tiffin, committee rooms and a liberal number of special rooms for the use of ministers, secretaries, and private members and party leaders. The Princes' Chamber has its separate set of contingent rooms. Three open courts with fountains separate the three chambers.

The acoustics of the Chambers present special difficulties on account of their size, semi-circular form, and the great height thought necessary for dignity and coolness and for effective clerestory lighting, skylights being undesirable under a tropical sun. The Legislative Assembly now consists of about 150 members, but the Chamber must be spacious enough to seat ultimately 300 to 350 members. The floor space and the lower walls have therefore been contracted, so as to avoid empty benches and vacant floor space, which are both bad for acoustics and depressing to speakers. The wall will be set back when the House grows in numbers. The panelling up to the height of the gallery is sloped forward at an angle which will reflect back the sound down to the members, and all reflecting surfaces on the ceilings and higher walls are covered with a sound-absorbing plaster tile, invented, made and much used in America. But for one of the essentials of good acoustics—a full House and full galleries—the architects, as well as the well-wishers of Parliamentary institutions, require the co-operation of the people of India.

Besides these greater buildings there have been built, for the most part by the architects of the Public Works Department, the bungalows big and small, the streets and squares for the habitation of the different grades of Ministers, Officers, clerks and menials who will work in the Government Offices and Legislative Building and elsewhere in the city. These have mostly been built and occupied some years, the occupants travelling by car and omnibus to the present city some 7 or 8 miles distant. In addition, the Department has built post offices, police offices,schools, hospitals, hostels for members of the Assembly, bazaars and shopping centres. Then there is Sir Edwin Lutyens' Record Office and his great War Memorial Arch and the temporary museum containing Sir Aurel Stein's frescoes from the deserts of Central Asia. The few living temples and shrines and the Junta Manta, the huge brick and polished plaster astronomical instrument built by a Maharajah of Jaipur, have been enclosed with walls and gardens, and the famous Sikh shrine has an especially honoured enclosure close to Government House. The Sikh Guru, who lies buried here, was condemned to death by the Emperor Aurangzeb and died with a prophecy on his lips that a great white race would come from the west and destroy the Empire of his executioner.

Sites have been allotted to the Princes of India, but few of them have so far availed themselves of the exceptional facilities for building which now prevail, but which will cease when the industries, workshops and railway systems improvised for the new city are dismantled. The contemplated new Railway Station has unfortunately not been built, but the railway line which formerly ran through the site has been diverted and now runs round by the old river bed below Humayun's Tomb and Indra-pat, and the new view of these two groups of ancient buildings adds greatly to the beauty and interest of the railway approach to the Capital. The roads are named, except for those of local significance, after great men and women of Indian history. After

Kingsway and Queensway and other royally named roads come the names of the Viceroys more especially associated with Delhi. Amongst famous Indians are Asoka and Prithri Raj; Feroz Shah and Akbar. One road is dedicated to Lady Hardinge, and open spaces are named after Sultan Raziyah and Nur Jehan. Next to the names of Clive and Hastings come those of two famous Empire builders who strove so valiantly for their country only to meet on their home coming with its ingratitude—Dupleix and Albuquerque.

Much more should be said on the building and engineering achievements, but we are lucky in having amongst us Sir Hugh Keeling, the engineering and organising father of the building of New Delhi, and I hope he will speak on this subject which is his own.

The raison d'être of the sites of all the former cities of Delhi has been the Jumna, and it is a misfortune for the new site that the flight from the mosquito placed the city where the river that once washed the walls of Shah Jehan's Fort and Palace, Feroz Shah's Fort, Indrapat and Humayun's Tomb, has now retreated from its well-known banks. But a future and wealthier India, proud of its Capital, may complete the plan which shows a great lake fed by a canal from the Jumna, as one termination of the central vista as well as the projected Durbar Amphitheatre at the other.

Speaking for the buildings only for which I am responsible, and more especially for the Secretariat, the principle which has prompted the design, as far as any principle in building is conscious or can be put into words, has been to weave into the fabric of the more elemental and universal forms of architecture the thread of such Indian traditional shapes and features as may be compatible with the nature and use of the buildings. The most pleasing characteristics, I think, in the old buildings of India are the wide, flat spaces of bare, sunlit walls, contrasted and enriched at rare intervals with the more elaborate features of doors, windows and balconies, which the Indian craftsmen love to adorn. Indeed, there is no more radical fact than the solid front to the public thoroughfare and the open court life within. The architecture of the south of Spain is distinguished by the same characteristics. I venture to suggest that the failure of so many attempts to adapt old Indian architecture to modern usage and conditions of life is due to the mistaken attempt to overload the close fenestration necessary for modern utilitarian buildings with too many "purple patches" of elaborate detail.

The Indian features which have been specially adopted are the Chajja, the familiar cornice of stone slabs which, supported on brackets or cove, overhangs the wall to a width of sometimes 8 or 9 feet. Its function is in stone that of the great eaves of Italian and Spanish buildings in wood and tiles, casting deep shadows down the sun-scorched walls and protecting the windows from tropical rains. The Jaali, or pierced stone or marble slabs of intricate patterns, have been largely used in windows, screens and railings. It would be interesting

to trace the historical origin of the Jaali; how far it may be derived from the cancelli or chancel screens, and the pierced masonry windows of Rome—and the connection of both with the Byzantine examples such as those in the mosque of Damascus and those taken, no doubt, in spoil from the East, in St. Mark's at Venice. Under Muhammadan influences they developed into an infinite intricacy of geometrical pattern. The Chattri, or open canopied turret, the umbrella or symbol of royalty, has been used very sparingly, and the Exedra, the high arched and domed portal that distinguishes the Mughal buildings.

A bold departure from Indian architecture has been taken in the planning and designing of the Secretariat by the omission of continuous verandahs to protect the walls from the sun. It was reasoned that verandahs on east and west walls are of little protection against the slanting rays of the sun, unless their height is so reduced as objectionably to darken the rooms behind in dull weather and in evening light, and that the heat clings in verandahs long after the sun has departed from the walls. On the other hand, experiments were made to prove that a very thick or hollow wall does not get heated right through even in the most torrid season. The heat, too, as the sun goes off it, radiates more quickly from the open than the covered wall. In the Secretariat the glass has been set on the inside of these thick walls and jalousie shutters on the outside, so that no sun need shine on and heat the glass. Moreover, by the use of shutters the lighting of the room can be regulated, the full direct light being enjoyed up to the twilight, a real boon to the late worker. The experience of the offices which have been occupied for the last few years seems to justify the departure; in fact, complaints so far have been directed rather to the coolness of the offices, due to some extent, I think, to the slow drying out of the thick walls.

It has been a disappointment that it has been impossible to call in the aid of the traditional skill of India in the arts and crafts. At the beginning in 1912, a petition, it may be remembered, was presented to the Secretary of State for India, signed by a good many distinguished people known for their interest in and knowledge of the arts, in favour of employing as designers of the new buildings the native master builders of India instead of alien and unsympathetic architects! There was no difficulty, however, in convincing the Viceroy of the fallacy of this petition as far as the architecture was concerned, but it was agreed that there was some truth underlying it in respect of the arts and crafts. The Government of India consequently inserted a clause in the Architects' agreements to the effect that it proposed to found a School of Craftsmen at Delhi to collaborate with the architects in the building. But the War came; then the post-war fever of economy, from the shivering fits of which we have hardly yet recovered.

But in the more essential and humbler crafts of masonry and joinery a wonderful work has been done. The stoneyard is perhaps unrivalled. Between 2,000 and 3,000 masons have worked through these years continuously and the

murmur of the saws has ceased neither by night nor by day. One wonders what these masons will do when the work stops! But India will be richer by many thousands of good masons and mistri who will return more highly skilled in their craft to their different stone-working districts. In joinery, as distinct from carpentry and wood-carving, Indians have been traditionally less skilled than in masonry—perhaps because wood furniture is little used. But in the Delhi joinery shops, started with the encouragement of Lord Chelmsford, the Sikhs have now reached the level of, and even overtaken, their skilled Chinese rivals. In the carving in stone and wood that the limited funds have permitted the skilled craftsmen have learned a less superficial and more virile touch and found a broader scope in harmony with the scale and restraint of the buildings.

Mr. Armitage, the master craftsman, whom the Government rather late and reluctantly sent to Delhi this winter, speaks highly of the capacity of the Indian carver, under the sympathetic encouragement of a fellow craftsman interpreting the drawings and models and inviting originality within the scope of the architectural design.

In case it may not be generally known, it may be as well to state that the contractors, all the workmen and craftsmen, the mistri, foremen and inspectors, are Indians, and that the only British employed under the rank of Executive Engineer and the Resident architects, are some dozen super-foremen. These have been the salt of the job, and speak with just pride of the good work done by their Indian fellow-workers.

Little, however, has been attempted to revive or give an opportunity to the many traditional Indian arts and crafts, some merely inactive from want of a market, some quite dormant. Through the medium of these much might have been done to enhance New Delhi in the eyes of India by giving expression to Indian ideas, to her symbolism, heraldry, history and philosophy, so far as these can be embodied in art. At the same time an outlet might have been given to the artistic and intellectual activities and self-expression of Indians. The Indian people are good sightseers; the old buildings gain much in live interest and beauty by the gayly dressed troops of visitors. They will surely come to see the New as well as the Old Delhi, and will, I believe, even now, and increasingly as knowledge grows, grasp the meaning to be read in the stone and marble of the buildings of their capital. But the sands are running out, and as the scaffolding is being removed, the opportunities for the craftsmen are vanishing. For the painters and sculptors, however, there is yet time to take advantage of this unique opportunity of the continuity of patronage and certainty of market which is necessary for any artistic revival.

I must here record something which we have achieved. A Committee of experts was appointed by the India Office on the initiative of Lord Hardinge to design Coats of Arms for the 12 Provinces of India. Personal heraldry may have become an outworn creed, but national heraldry, or the symbolical

expression by the Herald's craft of the historical sentiment of a nation, may still be a very living art. The new arms of the Provinces symbolise, with the few simple charges which good heraldry demands, the things or events which have distinguished or dominated each Province. The use of these shields and their symbols will save what little decoration we have been allowed, from being meaningless. As a frieze, too, round the dark rosewood panelling of the Princes' Chamber are blazoned and tinctured in enamel the shields of the 106 States which compose the Council of Princes.

The Government of India has just voted, most rightly and deservedly, 50 lakhs to the Indian Archæological Department. I wonder sometimes how much of our interest in archæology is prompted by the curiosity instinct in human nature, and whether the chief justification for the study of dead art should not be the teaching and inspiration it may give to living art in present and future generations. And might not the artists and craftsmen of India rightly claim that at least lakh for lakh should be spent on encouraging the artists of to-day, partly by the enrichment of the new capital, if only to give the Sir John Marshall of far-off future centuries something worth digging for in the ruins of the ninth Delhi!

And I think, too, that a claim should be put in by the New Capital Committee for some of that 50 lakhs for the founding of an art museum at Delhi. All we have there in the Capital is one small room in the Old Delhi Fort, and in the New Delhi a building containing Sir Aurel Stein's frescoes from Central Asia. They are indeed wonderful in their romance and beautiful in their art, but, may one venture to say, of limited educational value and inspiration to the artists of the present day, in proportion at least to their complete monopoly of museum space in New Delhi?

May I take this opportunity of suggesting that a fine gesture to India on the inauguration of her new Capital would be an appeal from high quarters to every British family with Indian connections and every rich collector in possession of Indian works of art, that they should make a gift of at least one object of art to New Delhi? The India Office, of course, could be relied upon to set a liberal example out of their rich store of Indian pictures. Lord Curzon once set a noble example of this kind in giving back, or getting some one to give back, that divine little Orpheus masterpiece to the pietra dura throne in the Divan-i-Am in the Mughal Palace at Delhi.

Delhi has 6 or 7 months of tolerable climate, or more if the rains are included, and 4 or 5 of these months have a perfect climate. It is, of course, a misfortune that its climate is not tolerable all the year round, but there is no such place with a climate to be so described in the plains of Northern India. If there had been the history of India might have been different, and it might not have been necessary for a race which recruited its vigour overseas to hold sway there for so long. But the test has yet to be made of the capacity of the new buildings, with their thick walls and roofs and the vast space they enclose from

the sun, to lengthen the more tolerable period of coolness in the plains. Science, in addition to motor transport and electric fans and the discovery of the malaria germ, may yet do more for the tropics by the invention of some cheap system of cooling the air—cheaper and safer manipulation of liquid air, as a hint to the inventor!—to mitigate the period in the Indian summer during which neither European nor Indian can work with comfort.

The success of Delhi as a pleasant and beautiful city will largely depend on the Government and votes of the Legislature for the full and clean maintenance of its avenues, lawns, gardens and fountains, both in the new city and in the surrounding circle of older Delhis, and for the afforestation of the Ridge necessary to temper the prevailing summer winds. If this duty is liberally accepted and performed, the capital of India, with its Delhis new and old, may become all one garden city and the pride of India, affording in the future full justification for the faith, courage and foresight of its founders.

It was the wise Sir Christopher Wren who said: "Architecture has its political uses: it establishes a nation." And when we consider the glorious part India took in the Great War, and in the Peace Conference at Paris, and her great stride forward in political development under the New Constitution, the founders of New Delhi would seem to have been prophetic in foreseeing her need of a new capital as an essential in the establishment of her ideal of national unity.

DISCUSSION.

THE CHAIRMAN (Lord Hardinge) said that the Society was greatly indebted to Mr. Baker for his very interesting paper. To the speaker personally it had been of absorbing interest, for he had always regarded new Delhi as his special child. No mother had ever been through a more difficult and anxious time in nurturing her offspring than he had been, from 1911 to 1916, in nursing that frail and delicate infant. There were many people who treated it very unkindly; some of them tried to strangle it, and some to mangle it, and others sought to starve it, but the new Delhi infant had a very strong constitution and happily survived all efforts made to put an end to it, and perhaps, owing to the very vicissitudes through which it had passed, this delicate child was growing up to a very strong and robust manhood. He had no fear that this new capital of Delhi would not some day be the crowning edifice of national unity, embodying Indian aspirations and the traditional imperial policy of Great Britain.

He hoped that Mr. Baker would pardon him if he corrected him in his statement that the Commission appointed by the Government of India, consisting of Captain Campbell Swinton (whom he was very pleased to see present that evening), Sir Edwin Lutyens, and Mr. Brodie, took, as he said, a masterful advantage of the absence of any obstruction in the surroundings of Delhi to the free planning of an ideal city. He did not wish to belittle in any way the efforts and work of that Commission, which he had always appreciated as being of great value; but he was afraid that the description given by Mr. Baker was not quite accurate. It was perfectly true, as Mr. Baker had said, that this Commission worked very hard, and spent the summer in 1912 at Delhi, in great heat, riding on an elephant round

and round Delhi looking for a site. It was in September that he was overjoyed on receiving a message to the effect that a site had been chosen by the Commission, and as soon as the site selected had been mapped out and the positions assigned to the principal Government buildings and to the roads, he went down to Delhi to inspect it, taking with him some members of his Council and also some engineers. They rode out to the proposed site, and he remembered so well his feeling of dismay on being brought to its central point. He had a feeling of oppression; there was no view, the site was shut in, and was close to a rocky hill, part of the prolonged ridge from which it was evident that great heat would radiate in the summer. Even on that October day it was, he remembered, very hot. He sat there on a stone and listened for nearly three hours to all that the Commission had to say in favour of the site, and he weighed very carefully their replies to his objections. But he was profoundly depressed, so much so that he remembered saying to one of his staff that he would sooner not build a New Delhi at all than build it on that site. He then mounted his horse and asked Mr. Hailey, the Commissioner of Delhi, to accompany him. He rode to the top of a hill some distance away, in order if possible to see if he could not himself find a site that would appeal to him more than the one which had been selected. When he reached the top of the hill he saw before him a most wonderful panorama of old Delhi, the domes and dimarets of the Jumma Musjid, Indiapat, Humayun's Tomb, Safdar Jang and the Qutub with the river Jumna, like a streak of silver, in the foreground, winding its sluggish way between its ever changing banks. It was to him a wonderful vision, and he turned at once to the Commissioner and said, "This is the site of the Government House." When the rest of the party arrived he told them what he thought, but he remarked that the top of the hill would not provide much space for a really fine Government House with all the surrounding ground which was requisite. An engineer officer, however, who happened to be present, said at once that there would be no difficulty in cutting off the top of the hill. That surprised him very much, though one ought never to be surprised at anything in India. And he was right. He (the speaker) accordingly gave directions for this new site to be investigated on the lines of the removal of the top of the hill, and about twenty feet of height was removed, thereby making a large plateau upon which there was ample room for both Government House and the Secretariat Buildings. This, with due deference to Mr. Baker, was the true story of the choice of the site of new Delhi.

He had at first intended that Government House should stand alone on the hill, but the architects convinced him that for many reasons it would be a finer scheme if the Secretariat were at the entrance of the plateau on the main approach to Government House, and he thought they were right. It was unfortunate that the war intervened to arrest the building of the new city, owing to the impossibility of getting the necessary steel girders and also for other reasons; but he was delighted to hear from Mr. Baker that the Secretariat Buildings would be completed and in occupation during the next winter, and that the Legislative Buildings would also be in use, and he hoped it would not be long before the very beautiful and imposing structure which Sir Edwin Lutyens had designed for Government House would be completed and in occupation by the Viceroy. He was quite convinced in his own mind that the city of new Delhi, so happily inaugurated as it was by the King and Queen, would in a few years' time be one of the finest and most beautiful capitals in the world. (Applause). Before concluding his remarks he wished to pay a tribute not only to the architects, but to all the officers and servants of the Government of India, for the energy and enthusiasm which they had put into their work, and in particular Sir Malcolm Hailey and Sir Hugh Keeling during the years that

he (the speaker) supervised the planning and building of the new city. He was glad to see the latter gentleman present, and hoped he would contribute to the discussion.

SIR HUGH T. KEELING, C.S.I., A.M.I.C.E., M.I.E. (Member of Delhi Imperial Committee) said that he responded with pleasure to the invitation to make a small contribution to the question to which Mr. Baker and the noble Chairman had alluded—namely, the " battle of the sites." Almost immediately after his arrival in Delhi, in the late autumn of 1912, he was asked by Lord Hardinge to sit on a small committee of which the late Sir C. P. Lukis, then Director-General of Medical Services in India, was chairman, and the late Col. J. C. Robertson, then Health Commissioner with the Government of India, was a member. The committee was asked to report on the relative merits of the northern and southern sites as regards healthiness and suitability for building. The data which the Committee had before it in respect of healthiness was a malarial survey which had been made by Captain (now Lieut.-Col.) Christophers, of the Indian Medical Service, and a quantity of data collected by a small body of engineers attached to the Town Planning Committee of which Captain Campbell Swinton was chairman. The committee reported unanimously in favour of the southern site, the lay-out of which was shown on a map displayed to the audience. The reasons, put briefly, were that Captain Christophers' malarial survey showed a spleen index number for the northern site of 90, and for the southern of 26, so that as regards malaria the northern site was impossible; and with regard to suitability for building the data put before the committee by Mr. (now Sir Thomas) Ward showed that the table of subsoil water for the northern site was very high. In a very considerable portion of the area which would have been required for building purposes that table of water during the average year was within four feet of the surface, and within a very much larger area there was risk of inundation; the area had actually been inundated during the preparations for the 1911 Durbar. In the floods of October, 1924, the previous record of the Jumna was surpassed, and the previous maximum water level above the railway bridge was beaten by over 2½ feet, so that if by any chance the northern site had been chosen, the streets would have been under water. He thought it would be agreed that as regards the suitability of the two sites the southern was eminently preferable.

From the very commencement a health officer was attached to the staff of the new city. The object of this was to keep the site clean, to look after the health of the people, and to prevent the breeding of the anopheles mosquito. The spleen index number for the southern site, which in 1912 was reported to be 26, was now considerably under 15. That was entirely due to the efforts of the health officers in keeping down the mosquitoes. The labour force employed on the works numbered at the outset 29,000, and after the war, when the preparation of the site was mostly finished, the labour force on the site of the work and at the quarries, which were at Dolpur and Bhartpur, a distance of 110 to 115 miles from Delhi itself, totalled from 15,000 to 20,000. The duties of the health officers were to keep this army of labourers free from epidemics of cholera and plague and so forth. They succeeded so well that from the commencement of the work until he left it in April, 1925, the only epidemic they had on the site of the work was the Spanish influenza of 1918. There had been cholera and plague all around them, but never cholera or plague in an epidemic form within the area of the building operations of the new city. He put that down to the watchfulness and care of the health officers and to the fact that for the water supply they insisted from the commencement on having a temporary filtered supply. With regard to the health of the new city, it might interest those

present to know that since " Baby Week " in India was established, the infant population of this area had invariably taken the best prizes, and the majority of the prizes, and the infants from the new city area had completely " knocked out " as regards class the infants from the old city area.

It might further interest those present to know how a problem of this kind was tackled. In the first place it was necessary to make an estimate for the works, and such an estimate could not be made unless one had some idea of what the population was going to be. An estimate of the future population was, therefore, attempted. This was done by classifying the supposed population into various categories, such as officers and clerks, tradesmen of various kinds, the ruling princes and their entourage, and, finally, the non-official population. The problem of finding out exactly how many people each official and tradesman represented was rendered fairly easy by taking the census reports of the Punjab and the United Provinces for the year 1911. As an illustration he might instance what had happened about the Government of India clerks. When the finance member at that time, Sir Guy Fleetwood Wilson, inquired what the population figure had been estimated at, he was told that it was about 65,000 people. He asked how this was made out, and it was pointed out to him that the biggest item was the Government of India clerks, who would amount to about 22,500, including their dependants. Sir Guy declared that this was impossible; he said that he paid the bills for their going up from Calcutta to Simla, and he could not credit this figure. In face of his unbelief, a " tahsildar," a minor official in the Government Revenue department, was placed on special duty to enumerate the clerks and their dependants. He took from three to three and a half months on the task, and his total figure was within 250 of the original figure on which their conclusions had been based from the facts given in the Census reports. Another illustration of the problem was afforded by the rather more difficult case of the officer class—that is to say, the ordinary European who lived in a bungalow. The speaker had occasion a good many years before to look into that question in the city of Madras, and he there found that an ordinary bachelor, living in a small house by himself, would account for something like twenty-five persons, including his servants and their children, and that a member of Council would account for something like fifty people in his compound. A mean average of 35 was taken. The Commissioner of Delhi took exception to that figure, but he was afterwards induced to accept it as a fairly correct estimate owing to the fact that Mr. (now Sir Geoffrey) de Montmorency had, curiously enough, been enumerating his own dependants, who numbered twenty-nine. The figures arrived at in framing the estimate for the population had been, as far as it had been possible to check them on the population returns furnished by the Health Office, entirely correct. The actual population of the city at the time he left it (April, 1925), was in the neighbourhood of 30,000. The great majority, of course, were workpeople, but by no means the whole. It had been stated that the new Delhi was likely to be purely an official centre. When he left in the spring of 1925, the number of leases concluded for private building operations was 180, and many of these buildings were in course of erection—not, however, as many as one would have liked to have seen.

He wished in the next place to turn to the size of the work which was being dealt with. With regard to the size of the central buildings themselves, if one took the distance from the front of the Great Place to the western extremity of the Indian garden behind Government House one would have considerable difficulty in squeezing it between the Admiralty Arch and Buckingham Palace. That might serve to give some sort of illustration of scale and of the character of the buildings and

the lay-out of the whole city. Parliament House was almost exactly half a mile in circumference. There was in the House a beautiful wide corridor all the way round, and in their Parliamentary sports the members could have a lively half-mile handicap right round their corridors, should the proceedings in the chambers become too boring. With regard to the actual volume of work to be done, there was, of course, in the first place a great deal of preparation on the site itself. Where Sir Edwin Lutyens' Record Office was to stand there was the old refuse from the brick kilns of bygone centuries, covering an area altogether of some twenty acres for a maximum height of 80 feet, and an average height of about 60. The whole site had to be levelled, and the débris was used to fill in the depressions where the water lodged and the mosquitoes bred. With regard to the distance of this new city area and the central buildings from the old city, a place would be noticed on the map where there was a junction of roads immediately east of the Parliament House. That was the point on the old road where the fourth milestone from the Kashmir Gate used to be. The distance from there to the temporary Secretariats in the Civil Lines was almost exactly 5¼ miles. It took about 15 to 20 minutes in a car to go from one centre to the other. Considering the time that was occupied by many people in London in getting to their places of business from their places of residence, he did not think that this distance and expenditure of time could in any way be called excessive.

With regard to the roads, there were four classes of main arteries; the width taken up for roadways for the two lower classes of main arteries was 76 feet, for the second class 120 feet, and for the first class 150 feet. The breadth of metalling varied from 16 feet, which was sufficient for two streams of traffic, to 48 feet up the central vista and 40 feet on the main avenues. The average width of metalling was 32 feet for the more important roads, and amongst the dwelling-houses 24 feet from kerb to kerb. He also gave a list of the trees which had been planted, both the temporary trees, cork, lilac, and so on, and the permanent trees, of which there were very many varieties. On the ridge afforestation was now proceeding, the total area to be ultimately afforested was 2,000 acres, and of this there had been already planted at the present time somewhere in the neighbourhood of 400 acres. At the time he left, about 200 acres of this area could be seen to be the beginning of a wood. In about ten years' time, he thought, the southern extension of the ridge would look green from end to end. The object of doing this was to minimise the effect of the "loob," which blew from the west right across the site, and it would, he thought, also add to the general moisture of the climate, ameliorating the excessive dryness often experienced in the months of May, June, and July.

Mr. Baker had said that the climate of Delhi was tolerable for seven months. The speaker ventured to differ from that opinion. He thought it was tolerable for a considerably longer period. From about May 20th till the end of July was really the only uncomfortable time in new Delhi. He had been there for 13½ years, and he had remained during the whole of one hot-weather season, and every other year he had never been away except during the months of June and July. He had done eight or nine hours' work a day, and he did not think at the present moment, he was unduly unhealthy in consequence. In years to come, when prejudice had been wiped away, and a little experience had been gained, the new Delhi would be the headquarters of the Government of India, and their camp office would be in Simla for the months of June and July.

The transport system for carrying out all the work consisted of 60 miles of railway track of 30 inch gauge, 60 miles of tramway track of similar gauge, and a variety of mechanical locomotive vehicles. They had a carrying capacity of 2,000 tons per day and upwards.

In conclusion Sir Hugh Keeling showed a number of lantern-slides with a view to refuting the accusation that the new Delhi was an arid waste. These were views of the gardens of Delhi, all of them very beautiful. He added that from Delhi there was sent to Wembley in 1924 a collection of models and drawings showing the scope of the work which had been done. One of his staff who was at home, but who had been employed in getting this exhibition together went to Wembley to see how the new Delhi was displayed. Unfortunately there was not room for the whole exhibit, and eventually he found it, to his dismay, lodged in a room over the entrance to which was written "The effects of tropical diseases."

CAPT. G. S. C. SWINTON (Chairman of the Town-Planning Committee of the new Imperial city of Delhi) said that he was quite sure that in the history of the world no city had had such an opportunity as Delhi from the architectural point of view. The Chairman on that occasion, then the Viceroy, showed great wisdom in selecting the architects who carried it out, and from the photographs which had been exhibited its scale and magnificence could be appreciated. He did not believe that any city had had the opportunity of achieving such spaciousness and fine architecture, and he hoped the city would be worthy of it for all time. After the Chairman's allusion to the choice of the site, he wanted to say one thing which he felt he must say in justice to his colleagues, Sir Edwin Lutyens and Mr. Brodie. The Chairman was perfectly correct in what he said about the siting of the great buildings, but he thought the audience might mix this up with the choice of the site for the whole new city. When his Committee was appointed to go out to Delhi a site on the northern side had been chosen. He remembered going to see Lord Roberts on the subject, and Lord Roberts only laid down one injunction. He said: "Do not build on the ridge," by which he meant the Mating Ridge. His Majesty the King said the same thing, "You must not build on the Ridge." It was holy ground. If they were warned off the Ridge, where then, on the north, could they build? Much of the land was liable to flooding. They were told that sixty-five donkeys had been drowned in one hollow not long before! Eventually they decided, with Lord Hardinge's agreement, on the southern site. Lord Hardinge, however, who was a very sick man a little later, might not be aware what tremendous pressure was exerted then to move them back to the northern. It was a very strong movement, and Lord Hardinge was a very sick man. (LORD HARDINGE: I was well enough to resist it.) The speaker knew that Lord Hardinge resisted it, but the pressure from all sides, and a good deal from home, was very strong, and he thought that his Committee, especially Mr. Brodie, who spoke from the engineering point of view, deserved a certain amount of credit for standing firm. (LORD HARDINGE: Oh, I agree.)

SIR CHARLES STUART BAYLEY, G.C.I.E., K.C.S.I., (Member of Council) proposed a vote of thanks to Mr. Baker for his Paper and to Lord Hardinge for taking the Chair. His own acquaintance with Delhi was limited, and he did not know that he had any special qualifications for proposing a vote of thanks, save that, except for the Chairman, he was probably the only person present who had been responsible for laying out and building an Indian city. This was the city of Patna, a small enterprise, of course, compared with New Delhi, but one that enabled him to understand the difficulties of that kind of work, and also how much more could be done if the funds were forthcoming. Mr. Baker's paper was a most able one, and members of the Society would have great pleasure in reading it when it appeared in print. They were also greatly indebted to Lord Hardinge, who had presided that afternoon as a labour of love.

The vote of thanks was accorded by acclamation, and was briefly acknowledged by Lord Hardinge, after which the proceedings terminated.

NOTES ON BOOKS.

GALVANIZING. A THEORETICAL AND PRACTICAL TREATISE ON THE SUBJECT, FOR THE USE OF WORKS MANAGERS, STUDENTS AND OTHERS. By Heinz Bablik. Translated by Chas. T. C. Salter. London: E. and F. N. Spon, Ltd. 12*s*. 6*d*. net.

Galvanizing is a term now well understood in the iron industry, as meaning so to coat iron with zinc that in moist conditions a protective polarisation is established, the metallic couple being regarded as in a galvanized or polarised state while there is bare iron, zinc, and a moist condition.

The first chapter, which treats of rust and its prevention, discusses the matter from a somewhat different standpoint, the rusting of iron like the corrosion of zinc being regarded as mainly due to the heterogeneous condition of the metal. A piece of iron well coated with zinc is regarded as covered by zinc " hermetically all over" (p. 3). In relation to such a condition, if, indeed, it is ever realised on a large complex piece, it seems quite correct for the author to say, " the hypothetical zinc/iron element can never operate ; one pole, the iron, being absent."

Theoretical aspects are discussed in a chapter treating of the electro-plating of iron with zinc ; a process now carried on commercially. The salt of zinc to be used as an electrolyte, strength of the solution, and effect of various additions come under the author's searching and thorough study. " The deposition of the metal constitutes a process of crystallization," he writes on p. 118, and the known effects of colloids on crystal formation give clues to many methods of obtaining bright deposits (pp. 122-125).

Looked upon broadly, the work before us is a study as to the best modern methods of obtaining protective coatings of zinc on iron by the four methods now in use :—(1) Hot galvanizing or immersion of the iron in molten zinc ; (2) Electrolytic deposition of zinc on the iron ; (3) Sherardising, that is, packing the iron in a mixture of sand and zinc dust, then heating to a temperature slightly below the melting point of the zinc ; (4) The Schoop method, in which a spray of molten zinc is driven in a reducing hot atmosphere against the iron ; the speed of the blast is somewhat over 450 feet per second, and sometimes the iron is separately heated to promote adhesion. Ordinary chemical methods of cleaning the iron being unsuitable for the Schoop (or zinc-spray) process, sand blast is used. The chapter on galvanizing by means of zinc spray includes ten illustrations, four of which refer to the treatment of objects far too large for the bath of molten zinc ; as, for example, a construction in iron lattice work (p. 151), or an iron bridge (p. 155).

Bold but reasonable theory by a chemist of ability, details of practice whether as regards production or testing, lucid descriptions and abundant illustrations conduce to make this book one which must prove of great value to everyone interested in galvanised iron.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JULY 5..British School of Archæology in Egypt, at University College, Gower Street, July 5th and 24th, 10 a.m. to 5 p.m., and July 14th and July 23rd, 6.30 p.m. to 8.30 p.m. Annual Exhibition.

Egypt Exploration Society, at the Society of Antiquaries, Burlington House, W. July 5th-24th, 10 a.m. to 5.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5 p.m General Meeting.

TUESDAY, JULY 6..University of London, at the Institute of Historical Research, Malet Street, W.C. 3 p.m. Mrs. Harold Williams, "The Fate of Pushkin's Manuscripts."

WEDNESDAY, JULY 7..British Indian Union, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 4.30 p.m.

FRIDAY, JULY 9..Egypt Exploration Society, at the Society of Antiquaries, Burlington House, W. 3 p.m. Mr. Henri Frankfort, "The Season's Work of the Egypt Exploration Society," illustrated by lantern slides.

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FRIDAY, JULY 9th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The One Hundred and Seventy-second Annual General Meeting for the purpose of receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments during the past year, and also for the Election of Officers and New Fellows, was held in accordance with the By-Laws on Wednesday, June 30th, at 4 p.m. SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, in the Chair.

THE SECRETARY read the notice convening the meeting, and the Minutes of the last Annual General Meeting, held on June 24th, 1925.

The following candidates were proposed, balloted for and duly elected Fellows of the Society:—

Abram, Ernest S., Manchester.
Adam, Lieut.-Colonel W., Kidderminster.
Allensby, Charles Reed, London.
Anderson, William, Joppa, Edinburgh.
Appleyard, Commander Rollo, J.P., M.Inst.C.E., R.N.V.R., London.
Barwell-Walker, Rev. Francis John, Ph.D., D.D., D.C.L., La Porte, Indiana, U.S.A.
Basu, G., B.A., Calcutta, India.
Bhaduri, S. N., Calcutta, India.
Blakoe, Robert, London.
Cann, John Osmond Gilbert, Montreal, Canada.
Choon, Maung Ba, Rangoon, Burma.
Cole, Lieut.-Colonel H. W. G., C.S.I., O.B.E., London.
Davis, George Schley, Boston, Mass., U.S.A.
Davis, Sam Pettengill, B.S., Cleveland, Ohio, U.S.A.
Dempsey, William L., St. Louis, Mo., U.S.A.
Dupen, William Henry, London.
Elmhirst, Leonard Knight, M.A., B.Sc., Totnes, Devon.
Ewing, Miss Gertrude Irene, Ilford, Essex.

Ferguson, Ollis Bryant, London.
Green-Armytage, Robert North, Bath.
Honiball, Charles Roland, M.I.Mech.E., Liverpool.
Jennings, George Louis, Arundel, Sussex.
Jones, Edgar, Bahia Blanca, Argentina.
Kentish, Hubert, London.
Leeney, Osmond Harold, Southwick, Sussex.
Longwell, Henry E., Hartsdale, New York, U.S.A.
MacFadden, Frederick Alexander Ray, Toronto, Canada.
McKay, William, Honolulu, Hawaii.
McKenzie, Austin Luther, Port Antonio, Jamaica.
Mendenhale, Edgar, Streatley, Nr. Dunstable.
Nicholson, Commander Richard Lindsay, D.S.O., R.N., Delhi, India.
Pakenham-Walsh, Ernest, I.C.S., Guntur, Madras, India.
Ponsonby, Charles, London.
Quinnell, Richard, London.
Rhodes, Russell Henry, London.
Saxon, Edgar J., London.
Sinha, Rajkumar A. N., B.A., Bhagalpur, India.
Sorlie, David, London.
Srivastava, L. N., Meerut, India.
Stebbing, Professor Edward Percy, M.A., Edinburgh.
Telfer, Buchan Fraser Smollett, London.
Townsend, Leonard, Hull.
Turner, Leonard George Henry, Ramna, Dacca, India.
Willi, Charles Henri, London.
Williamson, Charles Pennock, London.
Wilson, A. Leslie, London.
Wilson, Andrew, Sydney, Australia.

THE CHAIRMAN (SIR THOMAS HOLLAND) appointed Mr. G. E. Jones and Mr. A. C. Ross, C.B., M.A., scrutineers, and declared the ballot open.

THE SECRETARY then read the following :—

REPORT OF COUNCIL.

I.—ORDINARY MEETINGS.

The Chairman of the Council, Sir Thomas H. Holland, chose for the subject of his inaugural address, "The Organisation of Scientific Research throughout the Empire." In the course of this he paid a handsome tribute to the early work of the Society in this connexion, mentioning in particular two movements originated by it which did a great deal to stimulate national consciousness to the value of applied science, viz., the Great Exhibition of 1851, and the union of so-called mechanics' institutes, with its accompanying system of uniform examinations. He also referred to the still earlier work of the Society in promoting the cultivation of many crops in the colonies and India. Passing to the present day he reviewed the principal agencies now at work for the promotion of scientific research, including the National Physical Laboratory, the Department of Scientific and Industrial Research, and various organisa-

tions in the Dominions, Colonies and India. A few striking illustrations were quoted to show the practical financial results achieved by scientific research in various directions—results which show that the pecuniary gains to industry are out of all proportion to the cost of the researches.

Up to the present session The Trueman Wood Lectures had all been devoted to scientific subjects. They form a brilliant series, the lecturers being among the best known men of science of the day, viz., Sir Dugald Clerk, Sir Herbert Jackson, Sir Oliver Lodge, Sir Daniel Hall, Professor J. A. Fleming, Sir William Bragg, Sir William Pope, and Sir Ernest Rutherford. This year the Council decided that the Lecture should be delivered on some aspect of applied art, and, in response to their invitation, Sir Cecil Harcourt-Smith, late Director of the Victoria and Albert Museum, agreed to speak on " The Modern Note in Industrial Art." The Paris Exhibition of Modern Decorative and Industrial Art had just been fluttering the dovecots in certain industrial circles, and Sir Cecil's address was mainly directed to a study of the outstanding features of the Exhibition. As was to be expected, the lecture provided a sane and healthy criticism of the modern note. Whilst ready to welcome any fresh symptom of real progress, Sir Cecil was not prepared " to assist at the canonisation of half-fledged ideas, some of which at least had their spiritual home in Moscow "; but at the same time he had nothing but the warmest praise for the beautiful metalwork of Brandt and the glass of Lalique.

Mr. Ingleson C. Goodison, in his paper, "The Furniture of Hampton Court and other Royal Palaces," gave the result of much laborious research among contemporary inventories contained in the Harley manuscripts in the British Museum and other similar sources. His labours have thrown a great deal of light on the work of such men as William Farnebrough and his partner, John Burroughs, Gerrit Jensen and Henry Moss—cabinet makers, whose skill and genius equalled those of Chippendale, Sheraton and others whose names are in everybody's mouth. A great deal of information was also given regarding the original prices paid for pieces of furniture. In some instances a very large proportion of the cost was expended on the upholstery. Thus, a joiner might turn out a fine walnut chair at a cost of 35s., but by the time it had been upholstered its price would have become £17 10s., or, taking the present value of money, £170.

In his paper on "Colour Printing," Mr. David Greenhill gave an account of the development of letter press colour printing during the last 30 to 35 years. He described the various processes which have been in use during this period, including collotype, photostone, wharf-litho, Orloff, Cottrell, and photogravure. The paper was illustrated by a series of exhibits, which showed admirably the virtues of the different processes. Mr. Greenhill declared himself a strong advocate of photogravure, which he described as " the most beautiful method of printing yet evolved." He has himself done much to develop it, and he believes that it has before it a very great future.

Sir Alan H. Burgoyne in a paper, "The Future of the Motor Car," indicated the general lines on which he predicted that the motoring industry would develop. As his experience as an owner-driver extends over twenty-five years his criticisms of our present methods deserve very careful consideration. He stated that with the rapidly expanding business which he anticipates, the prices of light cars will rapidly fall, and he foretold the advent of a small 4-cylinder car which will be offered at £100 or thereabouts. He made a number of suggestions with regard to traffic regulations, the construction of roads and the dangers arising from the present system of cambering ; and he also urged British manufacturers, who already lead the way where luxury is concerned, to make a bold bid for the huge overseas market where the principal demand is for the large, high-powered, cheap, mass-production car.

Probably few people realise the size of the paint and varnish industry of this country. Dr. H. Houlston Morgan, in his paper, "Problems in Paint and Varnish Technology," stated that its annual value is about £33,000,000, and that the estimated loss which would result from rust and decay if paint or some such protective coating were not used, would be not less than £100,000,000 per annum in Great Britain. From these figures it is obvious that any researches tending to improve the quality of the paint and varnish used may result in large financial economies. Dr. Morgan indicated a number of the points to which research might be directed, including not only problems connected with the manufacture of paints and varnishes, but also problems relating to storage and keeping qualities, and to the principles and methods of application. The whole paper was a strong plea for the necessity of forming a paint and varnish research association ; and in the discussion which followed it was announced by the President of the National Paint Federation that the industry was on the eve of forming such an association.

A great deal of work has in recent years been conducted in the Hartley Laboratories of the University of Liverpool with a view to studying the best methods of transporting fruit. Professor J. McLean Thompson, who has been in charge of these experiments, delivered the Aldred Lecture on the subject, "Some General Problems of the Transport by Sea and Conservation of Ripe Fruit in Store." He urged that the natural ripening of fruit should be secured if possible, before transport or storage is attempted. There seems to be a possibility that fruits—like grain—can be maintained for a considerable time in a state of "dormant ripeness." It will, of course, be necessary to ascertain the exact conditions suitable for each kind of fruit, but if and when this is accomplished, the prospect is held out of our being able to enjoy in this country the rarest tropical fruits in perfection as full as that which they attain in their native lands. Another advantage claimed by Professor Thompson for his method is its cheapness, as cold storage and the expenditure which it involves will be dispensed with.

The Rothamsted Experimental Station was set up 83 years ago by Sir John Bennet Lawes, who established a Trust which he endowed with £100,000 to carry on the work in perpetuity. The object of the experiments has always been the same—to obtain knowledge of plants and soils for the benefit of agriculturists. Sir John Russell, Director of the Trust, in his paper, "Investigations in Agricultural Science at Rothamsted," gave an idea of the kinds of experiments which are conducted at the Station. For instance, it has been found that the application of superphosphate to cereal crops will hasten their ripening, and if this can be pushed forward by even a few days it will save the crops from the gout fly of barley, which can only damage the seed head at a very early stage. Another point on which much profitable research has been carried out is the investigation of the part played by nitrogenous bacteria in the growth of leguminous crops. The study of the life cycle of the organisms has led to the result that bacteriologists are now able to introduce these organisms into the soil with beneficial effects. Again, investigations into soil structure have revealed the reason why the farmer should allow the soil to become exceedingly dry and then wait for rain to re-wet it before he starts harrowing. By work on these and similar lines the Rothamsted Station has acquired a great store of valuable knowledge which it has placed freely at the disposal of agriculturists.

Physiologists have devoted much attention in recent years to the study of food values, and in these investigations the parts played by the various vitamins have received more and more attention. The functions of some of them are now fairly well understood. It is possible, for instance, to produce or to cure rickets by withholding or administering the antirachitic vitamin D, and the effects of vitamin A have also been carefully studied. In the case of other vitamins, however, little more than a beginning has been made. There seems to be a probability, for instance, that one of the vitamins has a definite effect on sex determination. A good deal of unscientific talk has been heard about this and other functions of vitamins, and much misapprehension exists in the popular mind upon the whole subject. It was, therefore, decided to invite Professor J. C. Drummond to read a paper on "Modern Views of Vitamins," and he described briefly and clearly the present state of our knowledge of these elusive subjects.

In the early days of wireless telegraphy it was thought by many that the curvature of the earth would limit the range of communication. As long ago as 1899, Mr. J. E. Taylor, writing in the *Electrical Review*, predicted that this would not be the case, and his prediction has been verified. The reason which he gave for his belief was that instead of the electric waves being directed rectilinearly, they were conducted by the earth. The more generally accepted theory is that the waves are kept near the earth surface by being deflected from the ionised layer in the atmosphere known as the Heaviside Layer. In his paper, "The Propagation of Electric Waves," Mr. Taylor set forth in detail the grounds of his belief, which, he contended, were not in anyway opposed to

Heaviside's theory, but rather supported it, for Heaviside himself did not mean to convey by his reference to a possible conducting layer anything more than that the existence of such a layer might limit the upward expansion of electric waves. The paper gave rise to a long and animated discussion in the course of which Mr. Taylor's views were subjected to some searching criticism.

The problems discussed by Dr. Mary Fishenden, in her paper, "Domestic Heating," were described by the Chairman, Professor Leonard Hill, as among the most important that can be imagined in connection with the health of our population, "because by our system of heating and ventilating rooms either the vigour of the English race could be kept up or it could be reduced to the debility and feebleness of a tropical people." Mrs. Fishenden, who has conducted a long series of researches into the merits of various methods of heating, discussed the respective merits and demerits of coal, coke, gas and electricity. At present day prices she estimated that the ratio of cost to produce a given effect by these means is 1 : 0.9 : 2.6 : 15.5. It must always be borne in mind, however, that before one can say which is the best means of heating for any particular room, one must know exactly the purposes for which the room is used If continuous heating is required, coal and coke have the advantage in point of economy, though even here one should take into account the labour saved by the use of gas or electricity ; while in such places as dining rooms and bedrooms, where heat may only be required intermittently, a very good case may be made out for electricity or gas.

Mr. Percy Dunsheath divided his paper, "Science in the Cable Industry,' into two parts. In the first he gave an idea of the wide field of science covered by the cable maker, and it is a surprise to many to learn that this includes not only electricity, physics, chemistry, engineering and metallurgy, but such apparently remote branches as botany, entomology and mycology. Various fibrous materials, such as paper, jute and cotton, are used in large quantities in cable manufacture, and a knowledge of botany is indispensable for the proper study of these ; cables for use in the tropics must be proof against the attacks of white ants and borer beetles, and here entomology is essential ; while mycology is important in identifying fungi which may attack a cable, and in connexion with certain problems dealing with the deterioration of cotton braiding, etc. The second part of the paper contained a description of the research laboratories of Messrs. W. T. Henley's Telegraph works. These cover a floor space of 14,000 square feet, and are fully equipped with the most up-to-date apparatus. The work of the various departments was fully explained, and a series of lantern slides was shown illustrating the different parts of the building from the high tension laboratory on the ground floor to the microscopic and photographic rooms up above.

Dr. Reinhardt Thiessen, of the Bureau of Mines, United States Department of Commerce, read a paper entitled "The Microstructure of Coal." This is a

subject to which he has devoted many years' work, and his researches have thrown a great deal of fresh light on the nature of the various kinds of coal and the manner in which they came to be formed. Among many other points, he dispelled the illusion that age was the chief factor in determining whether a coal was bituminous or anthracite, for both forms of coal were found in carboniferous systems, while the cretaceous system in British Columbia, which was millions of years younger than the carboniferous, contained anthracite. As a matter of fact, it was not age but pressure and temperature which decided the form of the coal. From a practical point of view Dr. Thiessen's work appeared likely to lead to important results, especially in simplifying the work of the chemist; for if the constituents of coal were accurately known, it would be possible to predict what products would be obtained by its heat treatment under given conditions. At present chemists were working to a very large extent in the dark.

Co-partnership, as defined by the Labour Co-partnership Association, is "a scheme which gives the employee a share in the profits of the business in which he works, a share in its capital, and a share in control and responsibility." Colonel J. H. Boraston, in his paper on the subject, particularly stressed the last point, which, indeed, is important as differentiating the scheme from profit-sharing plans. He paid a handsome tribute to the late Sir George Livesey, who launched his first Co-partnership Scheme in 1889. Sir George for several years had difficulty in persuading his fellow directors of the South Metropolitan Gas Company to accept Co-partnership, but since the day of its adoption peace and good will have ruled in the Company. It is sometimes said that Co-partnership is better fitted to a gas company than to any other form of business firm, because the employees are generally accustomed to work on a sliding scale basis. This may be true, but Colonel Boraston contended throughout his paper that Co-partnership is not a cut-and-dried scheme but a principle, which may be applied to any business, though the methods of application must vary in different cases.

The problem of providing a bridge between art and industry has not yet been satisfactorily solved in this country. Manufacturers are apt to complain that the art schools do not produce the kind of student who is likely to be useful to them in their designing studios, while the art schools are in many cases apt to ignore the practical limitations which are necessarily placed upon art when it attempts to serve industry. Probably the best hope for remedying this state of things is to get manufacturers and art teachers to meet together as often as possible in order that each side may understand the other's problems and discuss them sympathetically and with a view to the common good. For this reason the Council welcomed the paper read by Mr. R. A. Dawson on "Art Training for Industry and the Society's Competitions." In this he sketched the history of State education in art from the establishment of the Central Government School of Design in 1837 down

to the present day, and he suggested lines on which it might be further developed in schools or colleges of university rank and granting their own diplomas. In the concluding portion of his paper he made some criticisms of the Competitions of Industrial Design now conducted by the Society, urging among other things that it is undesirable to draw students away from their course of study. A number of prominent manufacturers were present at the meeting and the paper was followed by an animated discussion.

An interesting account of the duties of a Quartermaster-General, both in peace and war, was given by Lieut.-General Sir George MacMunn in his paper, " Some Aspects of the Business Side of an Army." The Q.M.G. is a " giant housekeeper " or " super wife," and he has to deal with the provision and distribution of food, the provision and storing of all equipment and arms, and every sort of household utensil and requirement, the provision of horses and motor transport, the veterinary care of animals, and all the problems of housing and moving an army. In some cases, *e.g.*, guns, rifles and clothing, the Army produces its own goods, and thus wholesale manufacturing is added to the Q.M.G.'s duties. Much of Sir George MacMunn's work was carried out in India, where the problems are often very different from those in temperate climates. He described, for instance, the establishment of a cheese factory in Karnaul, and how the cheeses had to be taken up to the hills in hot weather. Another portion of the paper which was of great interest was the reference to the campaign in Mesopotamia and the advance on Kut, where the provisioning of the army had to be carried on under extraordinary difficulties. Sir George MacMunn brought out very clearly one point of difference in the duties of the Q.M.G. in peace and in war. In war money is poured out lavishly, but it is almost impossible to get the goods ; in peace the goods can be obtained, but the Treasury keeps a very tight hand on the purse strings.

There is a common tendency to imagine that for purposes of transport the day of the horse is done. Mr. James Paterson, however, in his paper, " Horse Transport and Motor Transport," expressed the view that the horse has still a very useful part to play. He considered the problem as it exists in three typical districts : an old locality, such as Deptford ; an intermediate sub-town, such as Ealing ; and a new town, such as Wealdstone or Northwood. In the first case, where the streets are narrow and winding it is difficult to replace the horse, while in the last, where roads have been built recently, motors will probably be the rule. As to the intermediate district, he suggested that electric vehicles might be the most suitable, provided that the costs for the use of charging plant and current and of the vehicles could be sufficiently reduced.

Mr. C. F. Elwell, whose demonstration of " Talking Motion Pictures " last session attracted a great deal of attention, read another paper this year on " Radio : its Past, Present and Future." In this he summed up the enormous developments in radio-telegraphy and radio-telephony during the

last thirty years, in some of which he has himself taken a leading part. The amazing growth of broadcasting is so familiar to every one that there is no need to dwell on it; but there are many other developments, such as direction finding, radio beacons, leader cables, by which ships can be navigated safely in the densest fog, echo depth recording systems and so forth, of which the man in the street knows little or nothing. Among the problems still calling for solution, Mr. Elwell instanced the prevention of collisions at sea, a practical method for the collection and transformation of solar energy, further applications of photoelectric cells and amplifiers, etc.; and in conclusion he pleaded for the encouragement of amateur investigators to whom other sciences have owed so much in the past.

II.—Special Meeting.

To those who love the beauties of our English countryside, the rapid disappearance of many of our oldest and most beautiful cottages is a cause of bitter regret. In some cases they are falling to pieces because it is not an economic proposition to keep them in repair; in others they are being pulled down to make room for arterial roads or for gimcrack public libraries or memorial halls. A special meeting was held in May, when Sir Frank Baines read a paper entitled "The Preservation of Ancient Cottages." After sketching the conditions in which our village craftsmen grew up and evolved almost unconsciously those admirable arts which now appear to be moribund he showed on the screen a series of delightful cottages representative of all parts of the country. Many of the most beautiful of these have been demolished in recent years; many others will disappear shortly unless some practical steps are taken to save them. The steps which he suggested are outlined in these words:—

"Direction and financial assistance would seem to be the immediate need, and it is my privilege to be able to say that the Royal Society of Arts has undertaken to initiate and endeavour to organise a movement, directed towards the fina preservation of the cottage architecture of this country. With the great traditions behind this Society, and its magnificent record of work accomplished, it should succeed where others have failed; it will, I feel sure, collect together a band of enthusiasts whose interest in the problem must produce outstanding results of vital and permanent benefit to our country.

"The first essentials are sympathy and enthusiasm; knowledge and eager assistance; financial and otherwise. They are all available; they are waiting to be called into action; and the Council of this Society will call to a conference all those anxious to help and devise a scheme to accomplish our aims."

Steps will be taken shortly to call the conference at an early date.

III.—Indian and Dominions and Colonies Sections.

Seven Indian meetings, including the annual Sir George Birdwood Memorial Lecture, four Dominion and Colonial Meetings, and two joint meetings of the two sections, were held during the Session. The Memorial Lecture was

delivered by Sir Michael O'Dwyer, the subject being "Races and Religions in the Punjab." The other Indian papers were: "Recent Progress in Indian Forestry," by Professor E. P. Stebbing; "Indian Maps and Surveys," by Col. W. M. Coldstream; "Women and Children in Indian Industries," by Lady Chatterjee; "The New Delhi," by Mr. Herbert Baker; "The Military Record and Potentialities of the Persian Empire," by Lieut.-Col. Sir Arnold T. Wilson, and "Travels in the Kara-koram Himalayas," by Capt. B. K. Featherstone.

The Dominion and Colonial papers were: "The National Parks of Canada," by Mrs. Julia Henshaw; "France in North Africa," by M. Henry D. Davray; "Publicity in relation to the Problems of Empire Trade and Settlement," by Sir Basil Clarke; and "Nyasaland," by Mr. Charles Ponsonby.

The papers read at joint meetings of the two sections were: "The Imperial College of Tropical Agriculture," by Dr. H. Martin Leake, and "The Work of the Imperial Institute," by Lieut.-Gen. Sir William T. Furse.

The leading idea of Sir Michael O'Dwyer's paper on "Races and Religions in the Punjab," was the permanence of racial characteristics. This theme was developed in an illuminating account of the succeeding tides of immigration and conquest—Aryan and Scythian, Greek and Mongol—which flowed over Northern India from about 2,000 B.C. until the fifteenth century A.D. and of the various religious and ethnical groups of which the population of the Punjab is made up. The many radical differences of Pathan and Biluch—although they have both lived for at least twelve centuries in the same environment and have both been Sunni Muhammadans for over 1,000 years—derive from a fundamental difference of race. The author's treatment of the whole subject was enlivened by references to many humorous incidents, illustrative of racial characteristics, which had come to his notice during thirty years of close contact with the races of North-Western India.

Professor Stebbing's paper covered progress in Indian Forestry from the advent of the Forest Research Institute, following the Forest School, at Dehra Dun which, sanctioned in 1906 during the Viceroyalty of Lord Curzon, was opened in 1913, up to the present time. The paper dealt with the extensive developments which originated in the demands made upon the Forest Department during the war and culminated in the decision of the Government of India in 1918 to erect a much larger Research Institute a few miles outside Dehra, the site of the 1913 Institute not being sufficiently large for the purpose. Professor Stebbing included in his paper a review of the work of the various research branches of the Institute in Sylviculture, Botany, Zoology and Entomology, Chemistry, and Economics, and also a general survey of the Forestry position in the different provinces, with some remarks on the relation between the Provincial Forestry Departments and the Government of India.

In his paper on " Indian Maps and Surveys," Col. W. M. Coldstream described the various kinds of maps, from that drawn in 1619 by William Baffin on information supplied by Sir Thomas Roe up to the most modern maps now being published by the Survey of India, which have at different times been made to meet the varying needs of the merchant, the soldier, the administrator, the forest officer, the engineer, and the geologist. A number of interesting slides were shewn to illustrate various kinds of maps, topographical, cadastral and others required for particular purposes, and the progressive advances made in cartographical technique up to and including the reorganisation of the Survey Department, which resulted from the Survey Commission of 1905, and led to the adoption by the Indian Survey Department of all the most modern improvements in cartographical practice.

In a paper on " Women and Children in Indian Industries," Lady Chatterjee arrayed a number of facts and figures relating to the employment of women and children in the three major industries, in which, apart from agriculture, they are employed, viz., the organised textile industry, the tea factory industry, and coal mining. She described the conditions, not always satisfactory, under which they work, and drew attention to the serious problems arising from the divorce of women from natural home life and environment which, with some notable exceptions, where the conditions of village life have been created by enlightened employers, is the usual concomitant of their employment in factories and mines in India. The need of the provision of maternity benefits, properly trained midwives and women welfare workers, and of more adequate housing accommodation was fully dealt with and the hope was expressed that women factory Inspectors may be appointed, without whose help many of the problems referred to cannot be satisfactorily solved.

The approaching completion of " New Delhi," which, now in its fourteenth year, is so far advanced that the new Secretariat will be occupied this autumn, and the Legislative buildings next January, lent a special interest to a paper on the subject by Mr. Herbert Baker. Mr. Baker, after referring to the considerations which guided the Commission and the Government of India in the choice of a site for the new Capital, and after describing the site itself, gave an account of the form and lay-out of Government House, the Secretariat and Legislative buildings, and, in the case of the buildings for which he was personally responsible, of the principles which governed the choice of design and ornamentation. Mr. Baker, in conclusion, expressed the hope that an appeal might be made to Anglo-Indians and others who possess collections of Indian works of art, that they should each present at least one object of art as a contribution to the establishment of an art museum in New Delhi.

In a paper entitled " The Military Record and Potentialities of the Persian Empire," Lieutenant-Colonel Sir Arnold T. Wilson brought together a large amount of evidence from chroniclers and historians, ranging in date from the

period of the Old Testament to the nineteenth century, to shew that the Persians have always possessed to an exceptional degree a native valour and capacity for enduring hardship which only require leadership to become of high military value. The lecture was illustrated by an extraordinarily interesting cinematograph film depicting the annual Spring migration of the warlike Baktiari tribe with their flocks and herds from the plains, where they dwell during the winter, to the grass uplands, across rivers and high mountain ranges, which afford them summer pasturage.

"Travels in the Kara-koram Himalayas," was the subject of a paper by Capt. B. K. Featherstone, who described an attempt which he made in the summer of 1922, during a period of leave from military duties, to cross the unexplored Western Muztagh Pass over the Kara-koram Mountains into Central Asia. Capt. Featherstone's account of his thousand mile journey was enlivened by references to many thrilling incidents, such as the crossing of glaciers and rivers—the latter on twig-bridges swinging from 40 to 80 feet above the water. The interest of the paper was enhanced by some admirable lantern slides made from photographs taken by the lecturer during his expedition.

The question of the preservation of large open spaces of wild country for public recreation has become in a highly industrial country like Great Britain of such great importance that Mrs. Julia W. Henshaw's paper on "The National Parks of Canada," has a particular interest for us at the present time. Mrs. Henshaw, who is a Director of the National Parks Association of Canada, gave a pictorial description of the five "animal parks," the bird sanctuaries, forest lands, etc., making a total of twenty-seven National Parks, and added an account of the park administrative arrangements, in which fire protection plays an important part. The measures now being taken to make the parks accessible and available for public recreation by means of motor roads and bungalow camps were also fully described.

During the last three or four years a series of papers has been given on various African territories, with the object of bringing out and comparing their outstanding problems, which, while often appearing to be of the same nature, may reveal important differences on closer examination. Included in this series was a paper on "France in North Africa," by M. Henry D. Davray. After giving a short review of the 95 years during which the French flag has flown in North Africa, and indicating the historical reasons for the different administrative systems under which the provinces of Algeria, Tunisia and Morocco are now governed, M. Davray proceeded to survey the record of achievement in the matter of roads, railways, telegraphs, education, medical and poor-law administration, and, lastly, irrigation works, for which large sums have recently been earmarked. In the course of his survey, M. Davray paid a tribute to the constructive vision of M. Jules Cambon and the administrative genius of Marshal Lyautey,

who have rendered such signal services in establishing the French North African Empire in the satisfactory position in which it finds itself to-day.

In his paper on "Publicity in Relation to the Problems of Empire Trade and Settlement," Sir Basil Clarke emphasised the extreme importance of well-conceived publicity, based upon proved psychological principles, as an aid to policy. He showed how right publicity can assist the restoration of trade in the direction of more efficient production, better salesmanship and increased purchasing power, and in relation to overseas settlement he pleaded for closer co-operation between Policy and Propaganda, on the ground that, in any question involving mass mentality, the psychological and dramatic values, with which propaganda is concerned, are nearly as important as the real values which are the concern of policy, and that, therefore, to frame policy without regard to propaganda values, as is so often done, is an error of the first magnitude. Sir Basil concluded with the hope that the authorities responsible for the expenditure of the sums recently appropriated for the stimulation of overseas trade and settlement would not decide upon a plan of campaign before they had made an enquiry into the forms of propaganda available, their values and functions in a co-ordinated scheme, and the highest standards of technique and practice. Such an enquiry, he suggested, would greatly amplify the knowledge of the Government on an instrument of statesmanship which has a far wider application than to the immediate subject matter of the paper.

The obscurity out of which two recent events, the British Empire Exhibition and the visit of the East Africa Commission in 1924, helped to drag the little known British Protectorate of Nyasaland, was further lightened by Mr. Charles Ponsonby in his paper entitled "Nyasaland." After a brief sketch of the early history of the territory in the late eighties and early nineties of the last century, in which the Mission establishments and the names of Sir Harry Johnston and Sir Alfred Sharpe figure so largely, Mr. Ponsonby gave an account of the economic and agricultural progress which followed the building of the Shire Highlands and Central Africa Railways between 1904 and 1915, and, later, of the Trans-Zambesia Railway, the last link in which line of communication—the bridge over the Zambesi—seems likely to be completed within the near future. Mr. Ponsonby also discussed the question of the administrative future of Nyasaland and the native problem, to both of which he made suggestive contributions.

In a paper on "The Imperial College of Tropical Agriculture," which in the author's absence was read by Dr. A. W. Hill, Director of the Botanic Gardens, Kew, Dr. H. Martin Leake developed the theme of the increasing dependence, in the matter of food and raw materials, of the temperate portions of the earth's surface—which are already or are rapidly becoming, owing to growing population and industrialisation, unable to support themselves—upon the tropical countries. This dependence necessitates the organisation

of a really scientific tropical agriculture, including the experimental investigation of the types of crop and seed most suitable for particular districts, the study of plant and animal diseases, and the training of an adequate body of scientific agriculturists to assist the European planter and the native cultivator to farm upon the most progressive lines. Dr. Leake appealed for the generous support of individuals and companies interested in tropical development, and of the Imperial and Dominion and Colonial Governments, towards the building and endowment of the Imperial College of Agriculture at Trinidad, which is designed to serve as a centre for research and education in tropical agriculture for the whole Empire.

The recent re-organisation of the Imperial Institute lent a particular interest to a paper on "The Work of the Imperial Institute," read by Sir William Furse. After a short introduction, in which he gave an outline of the Institute's past history, Sir William proceeded to review the work of the re-organised Departments, viz., the Mineral Resources Department, the Plant and Animal Products Department, the Publications Branch and the Exhibition Galleries. He expressed the hope that the Galleries under the new arrangements would prove of much greater value to the expert and more attractive to the ordinary visitor. The paper emphasised the governing idea of the re-organisation—to provide an efficient machinery for correlating on the scientific side and making accessible for the use of the whole Empire all the results of the various lines of investigation and research which are being conducted at different centres throughout the Empire, including the Institute itself, bearing upon the development of the material resources of the Empire; and also, in the Exhibition Galleries, to carry on in a permanent and effective manner the work of the British Empire Exhibition in bringing the people of this country to a realisation of the possibilities and responsibilities of their Imperial heritage.

IV.—Cantor Lectures.

The first course, delivered before Christmas, by Dr. R. Lessing, was entitled "Coal Ash and Clean Coal." An exhaustive examination was made of the constituents of ash from fusain, durain, clarain and vitrain, and the origin of the inorganic constituents of coal was discussed. Methods of analysing ash were described, and a demonstration of examination by X-rays was given. Questions such as spontaneous combustion and the prevention of explosions by stone dusting, were dealt with, and a striking illustration was shown of the chemical method of coal-getting. The lecturer next described the preparation of coal for the market by hand-picking, screening, etc., and then passed on to the chemical and physical problems connected with the combustion process of coal. He pointed out that at present the coking industry has to deal with an immense incubus of ash, and he concluded by expressing the belief that within a very few years it will insist on receiving coal containing

but a small fraction of the proportion of mineral matter which is customary to-day.

The second course was given by Mr. H. P. Shapland, his subject being "The Decoration of Furniture." The methods of decoration were dealt with under three headings, moulding, veneering and lacquering. The development of each of these processes was illustrated by a very fine series of lantern slides in which appeared numerous masterpieces by the great cabinet makers of the past.

Dr. G. W. C. Kaye, who gave a course of lectures on X-rays and their industrial applications in 1921, delivered three lectures this session on "The Production and Measurement of High Vacua." With the rapid growth of the electrical industries the industrial importance of high vacua has increased at an astonishing rate, as was evidenced by the crowded audiences who attended these lectures. Dr. Kaye dealt at length with the construction and methods of operation of the numerous pumps used in producing vacua, and also with the molecular, ionisation and other gauges employed in their measurement. The course was fully illustrated with apparatus, and some beautiful experiments were shown.

"Thermometry" was the title of the fourth course by Mr. W. F. Higgins. The first lecture contained a short historical resumé in the course of which were shown slides illustrating the earliest instruments devised for measuring heat. Many of these were of great interest, as were also the first attempts at calibration. One instrument, for instance, appeared with its scale rising from "great cold" at one end to "great heat" at the other. In contrast with these were the instruments of extraordinary precision now in use at the National Physical Laboratory where temperatures can be measured to a very small fraction of a degree. The methods in which these thermometers of precision are manufactured, and the ways in which the calibration is corrected for various possible sources of error, were fully explained by the lecturer.

The fifth and last course of the session was delivered by Mr. Charles Reed Peers, on "Ornament in Britain." The development of ornament was traced from its earliest beginnings in prehistoric times, through the bronze age, and the period of Celtic art. The influences of the Roman occupation were illustrated, and these were followed and modified by the work of the Christian Mission, with its great centres in Iona and Northumbria. After various modifications had been introduced by the Danes and Norsemen, the next great influence arrived with the Norman Conquest, which gradually led to the evolution of Gothic Art, when the use of ornament reached its zenith.

V.—Dr. Mann Juvenile Lectures.

Under the Dr. Mann Trust, Professor Henry E. Armstrong presented to a juvenile audience two acts of a performance entitled "Alice in Wonderland at the Breakfast Table." The main idea underlying the presentation was

to set young people thinking about the various kinds of food which they eat—what they are made of, why they eat them, and what are their effects. Alice, who duly made her appearance through a looking glass, found at a breakfast table a group consisting of the Duchess, the Mad Hatter, the March Hare, and other well known characters, who discussed in the style of Lewis Carroll the chemistry of the curiously heterogeneous collection of eatables which were spread before them. The Mad Hatter conducted a number of experiments with a view to finding out the effects of these dishes, and his demonstrations were followed with much appreciation and not a little bewilderment by his audience.

VI.—Albert Medal.

The Albert Medal of the Society for the current year has been awarded by the Council, with the approval of the President, H.R.H. the Duke of Connaught, to Professor Paul Sabatier, Member of the Institute of France, Foreign Member of the Royal Society, Davy Medallist, Nobel Prizeman, "in recognition of his distinguised work in science and of the eminent services to industry rendered by his renowned researches in Physics and Chemistry, which laid the foundation of important industrial processes."

Professor Sabatier is a most distinguished chemist. He was assistant to Berthelot at the Collège de France, and in 1884 he commenced his long career as Professor of Chemistry in the Faculty of Sciences of Toulouse. In his earlier years he devoted himself mainly to researches in physical and inorganic chemistry, covering a wide ground which included numerous thermo-chemical measurements, determinations of the velocities of a number of reactions and studies of absorption spectra, as well as investigations of metallic sulphides and of the oxides of nitrogen and several of their compounds.

In 1897 he started those investigations in organic chemistry which have made him famous as the authority on catalysis. To him is due the method of catalytic hydrogenation through the agency of finely divided metals. This investigation has found industrial application in the production of solid from liquid fats. The work in this direction was followed up by an extensive series of researches on metallic oxides as catalysts, leading to catalytic methods of transforming alcohols and phenols into a variety of derivatives and leading to methods of syntheses which are daily being found to have an increasing importance from an industrial point of view.

Professor Sabatier has also contributed many memoirs on various subjects in agricultural chemistry. For his work on catalytic hydrogenation he was awarded the Nobel Prize in Chemistry in 1912, and in 1915 he received the Davy Medal of the Royal Society, being elected a foreign member in 1918.

Professor Sabatier is a man of science of a very high order, combining with exceptional ability in a wide field of science, the knowledge and power of concentration of a specialist. While actively engaged on engrossing researches,

he found time, as Dean of the Faculty of Sciences of Toulouse, to exercise a most valuable influence on matters connected with education and to play the prominent part in the creation of Technical Institutes for such branches of science as agriculture, chemistry and the application of electricity to industrial chemistry.

VII.—Medals for Papers.

Eleven medals have been awarded for the papers read before the Society during the current session—six for papers read at the Ordinary Meetings, three for those read in the Indian Section, and two for those read in the Dominions and Colonies Section.

The awards are as follows :—

Papers read at the Ordinary Meetings :—

David Greenhill, Director and General Manager, The Sun Engraving Company Ltd., " Colour Printing."

H. Houlston Morgan, Ph.D., B.Sc., F.C.S., President Oil and Colour Chemists' Association, " Problems in Paint and Varnish Technology."

Sir Edward John Russell, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station, " Investigations in Agricultural Science at Rothamsted."

Professor J. C. Drummond, D.Sc., F.I.C., Professor of Bio-Chemistry University College, London, " Modern Views of Vitamins."

Percy Dunsheath, O.B.E., M.A., B.Sc., M.I.E.E., Head of Research Laboratories, W. T. Henley's Telegraph Works Co., Ltd., " Science in the Cable Industry."

Reinhardt Thiessen, Ph.D., of the Bureau of Mines (U.S. Department of Commerce), " The Micro-Structure of Coal."

Papers read in the Indian Section :—

Professor Edward Percy Stebbing, M.A., F.L.S., Professor of Forestry, University of Edinburgh, " Recent Progress in Indian Forestry."

Colonel W. M. Coldstream, R.E., C.I.E., " Indian Maps and Surveys."

Lady Chatterjee, O.B.E., M.A., D.Sc., " Women and Children in Indian Industries."

Papers read in the Dominions and Colonies Section :—

Henry D. Davray, C.B.E., Chevalier de la Légion d'Honneur, late Correspondent for " The Daily Telegraph " in North Africa, " France in North Africa."

Charles Ponsonby, Managing Director, British Central Africa Company, " Nyasaland."

For many years it has been the practice that no medals should be awarded to members of the Council, or to readers of papers who have previously received medals from the Society. Acting on this rule the Council were precluded from considering the following papers :—

Lieut.-Colonel Sir Alan H. Burgoyne, M.P., A.Inst.A.E., " The Future of the Motor Car."

C. F. Elwell, B.A., " Radio: its Past, Present and Future."

Sir Frank Baines, C.V.O., C.B.E., " The Preservation of Ancient Cottages."

The Council desire, however, to express their high appreciation of these papers.

VIII.—Thomas Gray Memorial Trust.

Under the will of the late Mr. Thomas L. Gray, the Society was appointed residuary legatee of the testator's estate for the purpose of establishing a memorial of his father, Thomas Gray, C.B., Head of the Marine Department of the Board of Trade. The main object of the bequest is " the advancement of the science of navigation and the scientific and educational interests of the British Mercantile Marine."*

Up to the present the sum of £5,000 has been handed over by the executors to the Society, and this has been invested in 3½ per cent. Conversion Loan.

On the recommendation of the Thomas Gray Memorial Committee the Council have offered:

(1) A Prize of £100 for on essay on the following subject:—

A description of a voyage, with special reference to the questions of stability, rolling and pitching of sea-going vessels, and to the methods of determining the position of a ship approaching and making the land during thick weather.

The writer should take into consideration the many modern aids to Navigation, and describe the appliances used and their practical effect. He should also describe the methods employed in a vessel fitted with the ordinary equipment which every ship should carry, and include notes on steering, either with the ordinary, or with the gyro, compass, or both. The whole essay should be based on the writer's personal experience.

(2) A Prize of £50 to any person who may bring to their notice a valuable improvement in the Science or Practice of Navigation proposed or invented by himself in the year 1926 or in the years 1921-5 inclusive. Preference will be given to an invention of 1926.

The last day for receiving entries for both of these Prizes is December 31st, 1926.

With a view to encouraging the study of navigation by young students the Council have also offered three prizes of £10 each and five prizes of £5 each to the best student in the class of navigation in each of eight nautical schools.

IX.—Fothergill Prize.

Under the Fothergill Trust the Council have offered a Prize of £100 for an essay on " Fire Waste (Loss of Property by Fire) and its Effects on the Economics of National Life in Great Britain." The last date for receiving the essays is July 31st, 1926. Particulars of the Competiton were published in the *Journal* of March 8th, 1925.

* Further particulars of the bequest were published in the *Journal* of January 23rd, 1925, pages 241-3.

X.—Peter Le Neve Foster Prize.

Under the Peter Le Neve Foster Trust the Council offered a Prize of £25 for an essay on "The Effect of Trade Union Regulations on Industrial Output." The judges were:—The Rt. Hon. Lord Askwith, K.C.B., K.C., D.C.L., The Rt. Hon. George N. Barnes, C.H., and Mr. W. L. Hichens.

Thirty-six essays were submitted. The prize was unanimously awarded to Mr. C. G. L. Du Cann, Barrister-at-Law.

XI.—Annual Competition of Industrial Designs.

The third Annual Competition of Industrial Designs will be held at the Imperial Institute in July, by kind permission of the Director.

This year the competition is being held in the following sections:—Architectural Decoration (where prizes amounting to over £270 are offered); Textiles (where two Travelling Scholarships are offered); Furniture; Book Production; Pottery and Glass; and Miscellaneous. In the last section a number of prizes up to the value of £50 each are offered by various firms for posters, designs for boxes, show-cases, etc.

In order to contribute towards the cost of the competition and exhibition, the Council decided to charge an entrance fee of five shillings per section. The number of competitors this year is 561, as compared with 813 in 1925.

It has been the aim of the Council and of the various committees appointed by them to carry out this competition, to ensure that any designs approved by them should bear evidence that the designers possess not only exceptional artistic ability, but also a sound and practical knowledge of the materials and processes of their trades. The committees consist mainly of representatives of important manufacturing and commercial firms, and the judges nominated by them will not be likely to overlook the question as to whether a design submitted is suitable or not for the materials for which it is intended.

After the awards have been made, it is intended to exhibit a number of selected designs at the Imperial Institute; probably also exhibitions will be held at suitable centres outside London, where the designs will be brought to the notice of manufacturers likely to be specially interested in them.

As soon as the judges have completed their work it is proposed to issue, as in 1924 and 1925, a full report on the Competition, which will be published in the *Journal*, and circulated widely among manufacturers and competitors.

The Council have also decided to start a Bureau of Information at which will be kept the names and addresses of those candidates at the Annual Competition of Industrial Design whose work has been accepted for exhibition and who desire to obtain *bona fide* employment as designers. Although no guarantee of employment can be given, the information will be placed at the service of manufacturers in search of designers, and it is hoped that in this way the Bureau may be of real service in bringing manufacturers and designers into touch with one another.

The Council desire to take this opportunity of placing on record their grateful appreciation of the interest taken in the Competition by Her Majesty the Queen, who visited the exhibitions in 1924 and 1925, carefully inspected all the work, and on each occasion purchased a design. Her Majesty's gracious action has very greatly encouraged not only the Council and the various Sectional Committees, but also the competitors.

XII.—Examinations.

In response to a very widely expressed demand, the Council decided to inaugurate a third series of examinations to be held in July, in addition to those which have for many years been held at Easter and Whitsuntide. At first it was intended to hold the July examinations in a few subjects and in Stages I and II only, as the examinations were designed primarily to meet the needs of Continuation and Central Day Schools ; but it has been found necessary to modify the original proposal. In consequence of the general strike it was impossible to hold, in the County of London and some other districts, the examinations which had been arranged from May 10th to 14th, and it was decided to transfer the entries of those candidates who had been prevented from sitting then until July. This necessitated recasting the whole of the July time table, and adding a good many subjects.

The entries for this year are as follows:—

March.	May.	July	Total.
27,160	47,594	14,246	89,000

The total for this year, 89,000, shows an increase of 14,645 as compared with 74,346 in 1925, which was hitherto the record figure.

The liberality of the Worshipful Company of Clothworkers has enabled the Council, as in past years, to offer the usual silver and bronze medals. These medals are greatly valued by the successful candidates, and they contribute not a little to maintain the high standard of the examinations.

A report giving full details of the year's Examinations will be published in the *Journal*, as usual, at a later date.

XIII.—Oral Examinations in Modern Languages.

The Oral Examinations are still in progress in various parts of the country. Particulars will be given in the annual report on the Examinations.

XIV.—New Council.

The Vice-Presidents retiring under the ordinary regulations are: Viscount Burnham, the Earl of Durham, Dr. P. M. Evans, Viscount Inchcape, Colonel Sir A. Henry MacMahon, Senatore G. Marconi, and Sir Aston Webb. In their places the Council recommend Lord Bledisloe, Sir John O. Miller, the Duke of Northumberland (none of whom have served on the Council in any capacity during the current year), Sir Robert A. Hadfield, Sir Thomas H. Holland, Major Sir Humphrey Leggett and Sir Frank Warner.

The Other Members of the Council retiring are: Sir John H. Biles, Sir Edward Davson, Sir Robert Hadfield, Sir Thomas Holland, Major Sir Humphrey Leggett and Sir Frank Warner. In their places the Council recommend Captain Sir Arthur Clarke, Colonel Sir Arthur Holbrook, Sir Reginald A. Mant, Sir Richard Redmayne, Mr. Carmichael Thomas and Lieut.-Colonel Sir Arnold T. Wilson, none of whom (except Mr. Thomas) have served on the Council in any capacity during the current year.

The Council also recommend the appointment of Dr. P. M. Evans as a Treasurer in place of Mr. Carmichael Thomas.

XV.—Changes in the Staff.

On the death of Mr. Samuel Digby, C.I.E., the Council appointed Mr. William Perry, B.A.(Oxon.), late Fereday Fellow of St. John's College, Oxford, and of the Indian Civil Service, as Assistant-Secretary of the Society and Secretary of the Indian and Dominions and Colonies Sections.

They also appointed Mr. H. J. Dack Chief Clerk in succession to the late Mr. George Davenport.

XVI.—The Journal and the General Strike.

Thanks to the efforts of the Society's printers, Messrs. F. J. Parsons, Ltd., the *Journal* appeared without interruption and in its regular form during the General Strike in May. Only two or three other weekly papers in this country were published as usual during this period. The Council realise that this success was entirely due to the zeal of their printers, and they desire to place on record their appreciation of the services rendered by them to the Society at a crisis of unparalleled difficulty.

XVII.—Obituary.

The Society has lost a number of distinguished Fellows and two old and valued officers during the last twelve months.

Sir H. Acton Blake, who only joined the Society in 1924, was a very popular member of the Council, and his services were of particular value in connexion with the Thomas Gray Memorial Committee, of which he was Chairman.

Sir Philip Watts had served on the Council for a good many years, and he was also a member of the Thomas GrayMemorial Committee at the time of his death.

Sir Krishna Gupta took a great deal of interest in the proceedings of the Society while residing in London as a member of the Council of India, and he was a member of the Indian Section Committee.

Mr. Joseph Pennell read several papers and delivered a course of Cantor Lectures here. He frequently attended meetings of the Society, presiding on many occasions and speaking in the discussions.

Mr. Henry Wagner had been a Fellow of the Society for fifty-two years, having been elected in 1874.

Dr. Louis Starr was one of our American Fellows and a very warm friend of this country.

Among other notable Fellows who have died during the last year may be mentioned Sir John McLeavy Brown, Professor Lilian C. A. Knowles, Brigadier-General Henry Norlande Ruttan, Dr. John Edwin Rhodes, Mr. James Sykes Gamble, Mr. James Henry Howell and Mr. Edward Penton.

The two officers whom the Society lost were Mr. S. Digby, who had been Secretary of the Indian Section since 1890, and of the Colonial (now the Dominions and Colonies) Section since 1898; and Mr. George Davenport, who had spent over fifty-three years in the Society's service, and had been Chief Clerk since 1879.

Obituary notices of these have appeared in the columns of the *Journal*.

XVIII.—Finance.

The Financial Statement for 1925, published in accordance with Section 40 of the Society's By-laws in the *Journal* of June 25th, shows that the excess of income over expenditure for the year was £154 16*s*. 3*d*. It also gives a statement of the Society's investments and the trusts standing in its name.

XIX.—Building Fund.

The list of subscriptions to the Society's Building Fund published in the *Journal* of May 21st last, shows that the amount received up to that date was £43,343 10*s*. 5*d*. The list published on June 19th, 1925, showed a total of £42,948 17*s*. 5*d*., so that during the last eleven months the sum of £394 13*s*. has been subscribed. The cost of purchasing, renovating and decorating the Society's House was approximately £50,000, and the Council will warmly welcome any assistance in reducing the deficit, and thereby enabling them to carry on the Society's work unhampered by financial anxiety.

XX.—Rear Wall of the Society's House.

The widening of the Strand has brought the rear wall of the Society's House into a prominence which was probably never contemplated by its architects, the Brothers Adam. When the House was built but little attention was paid to the back, and it must be confessed that, as soon as it was brought into close proximity to the new buildings on either side of it, its ugliness became painfully manifest. The matter was brought to the attention of the Council, who at once realised the advisability of taking some steps to improve the appearance of the rear wall; but having regard to the fact that there is still a deficit of over £6,000 on the Building Fund, they were unwilling to expend further money on the house.

In these circumstances Sir George Sutton most generously intervened. Fifty years ago Sir George obtained a first-class certificate in Book-keeping at the Society's Examinations; he is now a member of the Council and a Vice-

President of the Society; and he expressed his desire to commemorate the jubilee of his first connection with the Society by bearing the whole cost of the decoration of the rear wall. His offer was gratefully accepted by the Council. Plans have been prepared by Sir Aston Webb and Son, and it is proposed to carry out the work during the summer recess.

THE CHAIRMAN moved the adoption of the report, which showed that the papers and lectures delivered had been of the usual very high standard. About fifty meetings had been held during the Session. One special feature of the Report was the remarkable growth of the Examinations. The Examinations, which had reached, what was then the record figure of about 30,000 entries before the War, began to jump up after the War in a remarkable manner, and this year there was again an increase, the total being something like 90,000 entries. During the last two years the Society's activities had grown in another direction, that being in the Annual Competition of Industrial Designs. There was an increase in the number of competitors last year over that of the inaugural year. This year the number had not actually increased, but we had put on a protective tariff in the form of an entrance fee of five shillings, and in spite of this there has been no material reduction in the number of competitors.

SIR CHARLES S. BAYLEY, G.C.I.E., K.C.S.I., seconded the adoption of the report.

The Report was unanimously adopted.

THE CHAIRMAN then proposed a cordial vote of thanks to Mr. G. K. Menzies (the Secretary), Mr. W. Perry (the Secretary of the Indian and Dominions and Colonies Sections), Mr. J. H. Buchanan (the Accountant and Examination Officer), Mr. H. J. Dack (the Chief Clerk), and to the other officers of the Society for their services during the year.

The vote of thanks was carried unanimously.

THE SECRETARY returned thanks for this expression of confidence in himself and in the other officers of the Society.

The ballot having remained open for half-an-hour, and the Scrutineers having reported, THE CHAIRMAN declared that the following had been elected to fill the several offices. (The names in *italics* are those of Fellows who have not, during the past year, filled the office to which they have been elected.)

PRESIDENT.

H.R.H. The Duke of Connaught and Strathearn, K.G.

VICE-PRESIDENTS.

Sir Charles H. Armstrong.
Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.
Viscount Bearsted, LL.D.
Lord Bledisloe, K.B.E.
*Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.
Sir Edward A. Gait, K.C.S.I., C.I.E.
Sir Robert Abbott Hadfield, Bt., D.Sc., F.R.S.
Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.
Sir Herbert Jackson, K.B.E., F.R.S.
Sir Robert Kindersley, G.B.E.
Major Sir Humphrey Leggett, R.E., D.S.O.
Sir Charles C. McLeod, Bt.
Sir Philip Magnus, Bt.
Sir John O. Miller, K.C.S.I.
Duke of Northumberland, K.G.
Hon. Sir Charles A. Parsons, K.C.B., LL.D., D.Sc., F.R.S.
Sir George Sutton, Bt.
*Alan A. Campbell Swinton, F.R.S.
J. Augustus Voelcker, M.A., Ph.D.
Sir Charles Wakefield, Bt., C.B.E.
Sir Frank Warner, K.B.E.
*Sir Henry Trueman Wood, M.A.
Sir Alfred Yarrow, Bt., F.R.S., M.Inst.C.E.

ORDINARY MEMBERS OF COUNCIL.

Llewelyn B. Atkinson, M.I.E.E.
Sir Frank Baines, C.V.O., C.B.E.
Captain Sir Arthur Clarke, K.B.E.
Sir William Henry Davison, K.B.E., D.L., M.P.
Sir Archibald Denny, Bt., LL.D.
Rear-Admiral James de Courcy Hamilton, M.V.O.
Col. Sir Arthur Holbrook, K.B.E., M.P.
Sir Reginald A. Mant, K.C.I.E., C.S.I.
Sir Richard Redmayne, K.C.B.
Carmichael Thomas.
Professor J. M. Thomson, F.R.S.
Lt.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O.

TREASURERS.

(*Two to be elected.*)

Lord Askwith, K.C.B., K.C., D.C.L.
Peter MacIntyre Evans, M.A., LL.D.

SECRETARY.

George Kenneth Menzies, M.A.

* Nominated by H.R.H. the President.

THE CHAIRMAN proposed a vote of thanks to the Scrutineers, which was carried unanimously.

SIR CHARLES McLEOD, Bt., proposed a vote of thanks to the Chairman for his conduct that day and on many other occasions. They all knew very well that whatever Sir Thomas Holland took up he did with all his heart, and the speaker was sure that all present would wish him to convey to Sir Thomas their cordial thanks for all the work he has done for the Society.

The motion having been duly seconded, the vote of thanks was carried unanimously.

THE CHAIRMAN, in acknowledging the vote of thanks, said that he had found his work very much lightened by the manner in which he had been backed up by the regular attendance at the Council meetings of his colleagues on the Council.

OBITUARY.

VIVIAN LE NEVE FOSTER, M.A.—Mr. Vivian Le Neve Foster, who was elected a Fellow of the Society in 1907, died at Upton Magna, near Shrewsbury, on June 29th at the age of 50. He was the only son of Sir Clement Le Neve Foster, F.R.S., and grandson of Peter Le Neve Foster, who was Secretary of the Society from 1853 to 1879.

Mr. Vivian Le Neve Foster was educated at Eton, where he won the Tomline Prize, and at King's College, Cambridge, from which he graduated as a Wrangler. After leaving the University he spent a term on the staff at Fettes, and then returned to Eton, where he was an Assistant Master and afterwards held a house. He retired some time ago in consequence of ill-health, which was due to a mountaineering accident.

NOTES ON BOOKS.

APPLIED CHEMISTRY: A PRACTICAL HANDBOOK FOR STUDENTS OF HOUSEHOLD SCIENCE AND PUBLIC HEALTH. By C. Kenneth Tinkler and Helen Masters. Volume II. Foods. London: Crosby, Lockwood and Son. 15*s*. net.

The title-page tells us that this is "a practical handbook," and on p. 2 we are informed that methods are given "for a complete examination of milk." Further, in the Preface we read of added theoretical matter which the authors hope will enhance the value of the book "as a laboratory manual." (p. V.)

With such a vision of an exceptionally valuable book before us, it is natural to turn to a place where an important, but rather controversial, subject is considered, for example, boric acid in milk (p. 21). We find that the authors mainly draw conclusions from colour reactions as, for example, a discrimination between yellowish, reddish and brownish tints of turmeric; that is, a colour test as contrasted with definitely analytical methods in which the boron is separated out in the form of a compound which can be weighed, and the purity of which can be proved at any time by purely physical characteristics. The Berzelius-Stromeyer method, in which

the boron is weighed as potassium borofluoride, becomes, by recent additions, available for every careful laboratory worker who cares to incur the requisite expense of time and material.

In respect to such colour indications as may be obtainable with turmeric, the authors are less definite and exact in expression than is desirable; this being especially so in relation to what they term "a saturated alcoholic solution of turmeric" (p. 21), and the instructions given in a footnote for its preparation. That which is known as turmeric being the root of a plant it is not easy to attach a definite meaning to the expression "a saturated alcoholic solution of turmeric." In Pereira's Materia Medica, Vol. II, Part I, 1855 ed., pp. 236 to 243, is to be found a remarkably full account of the turmeric roots (whether yellow or white), and in the full consideration of the uses of yellow turmeric root as a colour test, we notice the very desirable mention that not only boric acid but also hydrochloric acid or sulphuric acid may "change the colour of turmeric from yellow to brown" (Pereira *ut supra*, p. 240).

Turning over from p. 21 of the work under notice to p. 22, we see the general form and aspect of a chemical equation given to a statement of the effective alkalinity of 1 c.c. of decinormal caustic soda solution, although no true aspect of equation is involved. On p. 23 is an instruction to use "commercial sulphuric acid" in making a colour test, it being apparently assumed that every sample of such acid contains an impurity which is essential to the expected reaction; chemically pure sulphuric acid being ineffectual for the purpose. Immediately following on p. 23 is a similar case in which commercial hydrochloric acid is ordered. To use or recommend the use of an impure reagent merely because it is expected to contain another reagent which is essential to the reaction, involves many risks, as should be obvious to any chemical student. A movement for the use of the purest reagents obtainable and for a systematic study of conditions affecting them led to the issue of a 40 page booklet in 1915 by the Institute of Chemistry and the Society of Public Analysts jointly. In this and other writings which may be regarded as supplementary we have the basis of the standard practice of analytical chemists as regards reagents.

Notwithstanding occasional signs of haste and slackness, the book under notice is fundamentally good and deserves to find a wide circle of readers among the many who may wish to learn something of food, adulteration, and its detection. It is to be hoped that a new edition will be called for before long, and may give opportunity for a careful and leisurely revision of what some may regard as details of secondary importance.

HELMHOLTZ'S TREATISE ON PHYSIOLOGICAL OPTICS. Translated from the third German Edition. Edited by James P. C. Southall. Volume III. The Perceptions of Vision. Published by The Optical Society of America; also by George Banta Publishing Co., Menasha, Wisconsin, U.S.A.

This volume is the completion of the monumental work, in folio, noticed on pp. 794-795 of *The Journal* dated July 10, 1925, and our comments on the merits and importance of the undertaking apply fully to this volume, but we may remind our readers that the present issue of the great work of Helmholtz in English is historically true to the original text in the sense that additions necessitated by recent progress are given by footnotes, comments and a bibliography. Thus in the text itself we get an unadulterated aspect of the thoughts and mentality of Helmholtz in relation to physics as understood in his time.

The third and completing volume now under notice commences with a profound study of perceptions in general, and examples are given in support of the view that correct perception involves not only the perception itself, but also experience by which the individual has learned to interpret the perception: this view being a dominating feature of Berkeley's Theory of Vision, first published in 1709. One illustration given by the author (p. 9) is that "the tactile sensation of wetness is composed of that of coldness and that of smoothness of surface. Consequently, on inadvertently touching a cold piece of smooth metal, we often get the impression of having touched something wet."

The bulk of the text is concerned with perception of depth as involving binocular or stereoscopic vision. The text and supplementary matters taken together explain and illustrate all aspects of stereoscopic fundamentals.

Congratulations are due to all who have taken part in giving us this very notable and important work.

FOUNDATIONS OF THE UNIVERSE. By M. Luckiesh. London: Chapman and Hall. 15*s*. net.

This book is of American origin and printing, as we gather from the imprint at the back of the title page; the style being rather like that of the Western newspaper press, which is so often confident, mainly in short complete sentences, quaint in illustration or metaphor, and general rather than laboriously particular in every detail.

On p. 109 the author treats in his own way of primary or fundamental views in chemistry, and he includes this sequence of short sentences.

"Iron 'rusts' because iron atoms combine with the oxygen of water forming iron oxide which we term rust. Acid eats metals, clothing, and many substances. The action is merely a physical one—an interchange of atoms between the molecules of compounds involved. The explosions in the cylinders of the automobile engine are interchanges of atoms between molecules of different kinds. The resulting products are largely gases which desire a greater volume than the original products. Hence the pistons move and we joy ride."

Whatever may be the merits or demerits of the author's mode of treatment, one must recognise that strict and formal chemical accuracy in details is not always a characteristic. Take, for example, the first sentence of the above series. Iron in rusting does not decompose water as suggested, and the rust of iron is a far more complex substance than any oxide that can be formed by reaction between hot iron and steam; moreover, the tendency to looseness as to details runs through the book. For example, if we go forward three pages we find that in the table of elements calcium is described as an earth, p. 112.

Far reaching speculations are based upon the author's interpretations of modern researches as to atoms, molecules, motion, matter or relativity; and as an example of his teaching in these more profound aspects we may quote from pp. 75 and 76, where he says:—

"If we could impart to our bodies a velocity of light the entire panorama of world history would pass by in an instant. But we must not forget that space would be shortened to zero; that is, the dimensions of all objects in the direction of relative motion would shorten to nothing. Incidentally, our money 'goes fast enough' usually, but there would be an advantage in giving a gold piece the velocity of light, provided we could spend it under those conditions. Its mass would then be infinite."

The mathematical contention that matter moving at the speed of light is or must be infinite as regards mass involves many apparent contradictions; hence those who uphold this mathematical contention often regard it as a *reductio ad absurdum* of the proposition that matter, as such, is capable of being moved with a velocity as great as that of light. In "Science and Method," by Poincaré, as rendered into English by Maitland and recently published by Messrs. Nelson, we find (p. 207) a cautious and profound study of the various aspects of the subject.

Experimental efforts to communicate high rates of speed to actual masses of matter, as, for example, those of Henriot and Huguenard, described on p. 930 of *Nature*, June 13, 1925, scarcely bear on the subject, so trivial are such speeds compared with that of light, but there seems to be a general impression that matter is a passive form of energy and that all aspects of matter would cease to be matter at a velocity approximating to that of light; this involving such stress as may at first disintegrate matter into protons and electrons, a view which appears to receive certain aspects of confirmation from the recent studies of Eddington on the source of stellar energy. In *Nature*, May 1, 1926, p. 29 of the supplement, Eddington, after suggesting new but convincing views regarding the source of stellar energy, assumes for the central region of the sun and some other stars a critical temperature of 40,000,000° Centigrade, and he conjectures that energy may "issue freely from matter at 40,000,000° as steam issues from water at 100°."

THE EARTH AND THE STARS. By Charles G. Abbot. London: Chapman and Hall. 15*s*. net.

We can cordially welcome this book which is of American origin both as regards authorship and printing; it being calculated to engage the mind of the casual reader and to lead him to a study of the many ways in which modern physical science and a study of terrestrial characteristics bear on astronomy. In short, the book is not only a concise, well illustrated, and lucidly written text-book of astronomy, but it also includes a summary of modern astrophysics; a branch of science which may be considered as commencing with Fraunhofer (1787-1826) in following the path which Wollaston had faintly indicated, and mapping out about 600 dark lines of the solar spectrum. On pp. 22-24 is an interesting account of the life and work of Fraunhofer, and his portrait on plate 3 is one of a series of twelve portraits of the more recent pioneers.

The Fraunhofer lines as data of position, and as prime elements in long sequences of thought or research, are prominent throughout the book. For example, on plate 13 we see two solar line-spectra as affected by the lower temperature and the magnetism of a sun-spot, these having conduced to bring about something which at first sight looks like a narrow smeared band crossing the spectral lines about medially, and the few pages immediately following this plate give a fund of recently acquired information as to magnetic and other influences of sun-spots. Plate 22 shows us a photograph of the yacht "Carnegie", which is built of non-magnetic materials, and has sailed over 300,000 miles in marking magnetic surveys.

Mr. Abbot's volume does credit to the series of books now being issued by Messrs. Chapman and Hall as "The Library of Modern Sciences," carefully studied exact wording making it easy to read. The abundant illustrations, many apt quotations, and a good summary of modern views as to atomic and molecular relations to electricity and intercosmic physics justify a presage that Dr. Abbot's book will meet with cordial appreciation in Great Britain.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

SPECIAL MEETING.

THURSDAY, JULY 8th, 1926; SIR RICHARD REDMAYNE, K.C.B., late H.M. Chief Inspector of Mines, in the chair. An address on "The Economics of the Coal Industry" was delivered by Mr. Frank Hodges, Secretary, International Miners' Federation.

The address and discussion will be published in an early number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION

MONDAY, MAY 31ST, 1926.

Brigadier-General SIR PERCY SYKES, K.C.I.E., C.B., C.M.G., in the Chair.

The CHAIRMAN said he had much pleasure in introducing the lecturer, Lieut.-Col. Sir Arnold Wilson, who had belonged for some years to what Lord Curzon had described as the finest service in the Empire, namely, the Indian Political Service. Following the usual practice of that Service, he had studied Persia, the country in which he served, from every point of view. After the War, not finding sufficient scope, like a good many of the younger men, he became the manager of the Anglo-Persian Oil Company, a great commercial enterprise in Persia. Not only was it a great commercial enterprise, but it was a beneficent enterprise and was helping Persia more than any other means towards modern education, modern efficiency, and also wealth. He had much pleasure in calling on Sir Arnold Wilson to read his paper, which would be followed by a film illustrating the annual spring migration of the Bakhtiari tribe from their winter quarters in the plains to the grass country situated on the other side of wide rivers and high mountain ranges.

The following paper was then read:—

THE MILITARY RECORD AND POTENTIALITIES OF THE PERSIAN EMPIRE.

By LIEUT.-COL. SIR ARNOLD TALBOT WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O.

The central position of Persia—athwart the land routes from West to East, and from the Caspian to the Persian Gulf—is one of the great facts of ancient and modern geography. This position invested Persia from the earliest times with peculiar importance; the nature of the country, a high plateau, subject to extremes of heat and cold, cut off from Turkey and Arabia by a broad and lofty mountain chain, which can be profitably inhabited only by pastoral tribes who retain the nomadic habit, is naturally favourable to the development of a martial race, and it is as a martial race that the Persians are first known to us in the pages of history.

The earliest references to the military power of the Persians are in the Bible, cf. 2 Chron. XXXVI, 23—" Thus saith Cyrus, King of Persia, All the Kingdoms of the earth hath the Lord God of Heaven given me."(1)

Esther I, 1-3—" Now it came to pass in the days of Ahasuerus (this Ahasuerus which reigned, from India even unto Ethiopia, over an hundred and seven and twenty provinces:)

That in those days, when the King Ahasuerus sat on the throne of his kingdom which was in Shushan the palace,

In the third year of his reign, he made a feast unto all his princes and his servants; the power of Persia and Media, the nobles and princes of the provinces, being before him."

Plato, who lived in the flourishing times of the Persian monarchy, says:

> " The Persians were originally a nation of shepherds and herdsmen, occupying a rude country, such as naturally fosters a hardy race of people, capable of supporting both cold and watching, and, when needful, of enduring the toils of war." (2)

Herodotus tells us that after valour in battle it is most reckoned as manly merit among the Persians to show the greatest number of sons. He gives a minute account of their organisation and equipment. Commenting on the battle at Plataea, against the Spartans, he says:

> " Now the Persians were neither the less valorous nor the weaker; but they had no armour, and moreover they were unskilled and no match for their adversaries in craft; they would rush out singly and in tens, or in groups great and small, hurling themselves on the Spartans and so perishing . . . So long as Mardonius was alive the Persians stood their ground and defended themselves, overthrowing many Lacedaemonians, but when Mardonius was slain and his

(1) See also Ezra I, 2.

(2) Plato, De Leg., iii. *cap*. ii. p. 695. (See Heeren, Historical Researches, Vol. I. Asiatic Nations, Persians, p. 331).

guards . . . . the rest, too, yielded and gave way before the men of Lacedaemon." (1)

Could any tribute to Persian courage be higher?

Arrian assures us that:

"The Persians" when, under Cyrus, they conquered all Asia, "were but a poor people, inhabiting a rugged country and approximating closely in the austerity of their laws and usages to the Spartan discipline."(2)

Heeren adds that:

"The host of Cyrus, as was generally the case in Asia, consisted principally of cavalry, perpetually accumulating fresh recruits from the conquered nations (which also took place with the later Persian armaments), and thus his wars resembled, in some sense, the migrations of an entire people, who, for the time at least, were transplanted from their original seats to other countries." (3)

Xenophon refers to "the discipline of the Persians," and "ancient Persian bravery," as proverbial. (4)

"There is," however, as Shakespeare says, "a tide in the affairs of men," and, by the time of Artaxerxes, says Gibbon, (5).

"The Persians, long since civilized and corrupted, were very far from possessing the martial independence and the intrepid hardiness both of mind and body, which have rendered the northern barbarians masters of the world. The science of war, that constituted the more rational force of Greece and Rome, as it now does of Europe, never made any considerable progress in the East. Those disciplined evolutions which harmonise and animate a confused multitude were unknown to the Persians. They were equally unskilled in the arts of constructing, besieging, or defending regular fortifications. They trusted more to their numbers than to their courage; more to their courage than to their discipline. The infantry was a half-armed, spiritless crowd of peasants, levied in haste by the allurements of plunder, and as easily dispersed by a victory as by a defeat. The monarch and his nobles transported into the camp the pride and luxury of the seraglio. Their military operations were impeded by a useless train of women, eunuchs, horses and camels; and in the midst of a successful campaign, the Persian host was often separated or destroyed by an unexpected famine.

But the nobles of Persia, in the bosom of luxury and despotism, preserved a strong sense of personal gallantry and national honour. From the age of seven years they were taught to speak truth, to shoot with the bow, and to ride; and it was universally confessed that, in the two last of these arts, they had made a more than a common proficiency. (6) The Persian nobles (so natural is the idea of feudal tenures) received from the king's bounty lands and houses, on the condition of their service in war. They were ready on the first summons to mount on horseback, with a martial and splendid train of followers, and to join the

(1) Herodotus I. 136.

(2) McCrindle, The Invasion of India by Alexander the Great, p. 86.

(3) Heeren. *op. cit.* p. 337.

(4) Cyropaedia, VII. 5, 67.

(5) The History of the Decline and Fall of the Roman Empire, Vol. I. p. 274f

(6) The Persians are still the most skilful horsemen, and their horses the finest in the East.

numerous bodies of guards, who were carefully selected from among the most robust slaves, and the bravest adventurers of Asia. These armies, both of light and of heavy cavalry, equally formidable by the impetuosity of their charge and the rapidity of their motions, threatened, as an impending cloud, the eastern provinces of the declining empire of Rome."

The pages of history, from this date onwards, bear little testimony to the military potentialities of Persia until the arrival on the scene of the Mongols under Timur, who "declared his esteem of the valour of a foe, by extirpating all the males of so intrepid a race." ([1]). Timur was an optimist. The survivors performed their parental duties to such effect that, two centuries later, Persia was again populous and martial.

Albuquerque, in the Commentaries([2]), pays an indirect tribute to the bravery of the Persians whom he fought at Naband, near Bandar Abbas, in 1508, saying that "in these parts, Persians are reckoned for the bravest men in the world."

Teixeira (1586-1605), in a "Short Account of the Most Notable Provinces and those that have continued longest under the Dominion of Persia," says:

> "The whole country of Persia is for the most part well supplied with provisions, ... The people are fair, handsome, etc. . . . They generally fight on horseback, with spear and shield, bows, arrows, scimitars, coats of mail and maces; and ride with short stirrups, and with their horses caparisoned. In warfare they are formidable and very dogged therein."

Pietro della Valle, who travelled in the East from 1615-26, speaks highly of the valour of the Khans and Sultans in command of units in the field, but criticizes the absence of military organisation, tactics or strategy.

Herbert, who visited Persia in 1626-7, writes of the Persians that:

> "they are valiant, proper for the most part, olive-coloured, mirthful and venerious . . . they never ride without bowes and arrowes . . . which, though not comparable to the gun (an instrument they now make practise of) yet they have been famous for their archery."

Olearius (1633-39) affirms that "the Persians hate and contemn cowards, and the officers who neglect their duty in the wars are most severely punished."

Tavernier, in Persia about 20 years later, curiously enough, is silent on the subject.

The learned Doctor Fryer (1672-81) makes no observations on the quality of the Persian army or soldiers, but refers to the lack of personal valour on the part of the then Shah—Shah Sulaiman.

> "That which he least cares for is to go forth armed at the head of his Army, against his enemies, chusing rather to be Terrible at home under the Persian Banner (which when displayed is a Bloody Sword with a double point, in a White Field, and is always carried next the Emperor's person) than become

([1]) Gibbon, *Op. cit.* Vol. VIII. p. 129.

([2]) Vol. I, p. 250.

Formidable abroad to his Foes. Let others reap those hazardous Praises of Grinning Honour, he has no stomach nor no mind for Feats of Arms."

This period was undoubtedly one of decadence, a prelude to the short-lived Afghan domination of Persia. The cause is not far to seek—the personality of the sovereign and his immediate predecessors.

This is made clear by Chardin (1671) ([1]). He says in effect:

"The Persians, if I dare say so, are naturally brave and warlike, the honour and flower, so to speak, of Asiatic peoples, the founders of the most ancient and extensive monarchy; for, in her beginnings, she was mistress of the East, as is shewn in Gen. XIV, where it is said that the kings which made war with Chederlaomer, had been his vassals. The conquests of Abbas the Great, one of the last kings of Persia, of all the neighbouring peoples, without the help of any foreign troops, show that Persia is capable of making great progress by the power and courage of her people alone; but the long period of peace which she has enjoyed since the death of this great king, 80 years since, and the bloody rule of his successors, has debased the courage and almost extinguished this power. Luxury, sensuality and idleness, on the one hand, and the study of letters on the other, have also had the effect of making the Persians effeminate."

Later on in the same work, he says:

"It must not be supposed that military discipline is observed by the Persian troops as it is with us; sentry duty, guard-house, drill, evolutions, and such commendable things in the art of war, are unknown in the Orient."

It is the fact that, under Abbas the Great (1585-1628) the country had made, single-handed, immense territorial progress; but the peace which had ensued upon his death brought in its train the destructive influences of ease and luxury. Abbas himself had been reared in camps, but he caused his children to be brought up in the *andarun*, and no education could be more enervating; for the future it was fatally so.

From the ruins of the Safavi dynasty of Persian kings arose a great Conqueror, in the person of Nadir Shah (1736-1747), a soldier and a commander of soldiers, possessed of marvellous qualifications. To him the exigencies of a military profession—strategy, drill, discipline and duty—were stern realities to be acknowledged and practised.([2])

History has, in 1925, repeated itself!

Hanway (1743)([3]) says that Nadir's standing army was computed at 200,000, composed of the following, among other elements:—

50,000 Afghans, who, he says, "use the bow, lance and sword, and are very brave."

20,000 Afshars, the people to which Nadir himself belonged.

6,000 Usbeg-Tartars of Khiva, Bukhara and Samarqand.

6,000 Turkman Tartars, and 6,000 Baluchis.

([1]) Langles Edition, Vol. V. p. 294.

([2]) Sir F. Goldsmid, J.R.U.S.I. 1880.

([3]) An Historical Account of the British Trade over the Caspian Sea, 1754.

"All of them," he says, "wear sabres, in which they, as well as the Persians, are very dexterous . . . they are seldom exercised except in shooting with the bow, or with a single ball at a mark, at which they are very expert."

The rifle had come by this time into use in Persia, as elsewhere, and the Persian proved an apt pupil. Nadir showed his perspicacity and knowledge of men, for, says Colonel Drouville(1) a French officer, born in Persia,

> "he gathered together in his army Arabs, Kurds, Turkmans, Afghans, and Indians, and by this means excited the emulation of the Persians who, being naturally proud and unable to suffer that their chief's success should be attributed other than to themselves, fought ten times better than if they had been alone."

The 19th century in Persia opens, to quote Lord Curzon's work(2), published in 1891, upon a "yet unexhausted epoch of submission to foreign leading-strings, in the futile effort to infuse some stability into the mobile and dissolvent atoms of an Oriental fabric." The Persian Army, not to mention other departments of State, was subjected to a series of experiments in reorganisation, by the agents of various European nations successively—France, England, Germany, Italy, Austria and Russia.

Neither the genius nor experience of Nadir Shah produced any digested military regulations. He did not require them. His enemies, for the most part, were undisciplined, like his own troops. Courage and strength of arm were all he wanted; and, a public robber at the head of his wild and rapacious tribes, he broke into kingdoms, plundering, despoiling and leaving a desert, rather than an empire, behind him. The same style of warfare, whether for defence or aggression, continued through all the successive reigns, from Karim Khan to Fath Ali Shah; till the genius of one man, having laid almost all Europe at his feet, cast his eye towards Asia, and, hoping to grasp it also, attempted a first step towards it by making a friend of Persia, and then changing the nature of her military character.(3) By the arrival of the Gardanne mission, Buonaparte advanced his aims; this was the first of the series of experiments alluded to by Lord Curzon.

But, according to Ker Porter and Morier, it was Abbas Mirza, the Vali Ahd, or heir apparent who, about 1800, introduced regular training and European discipline among the Persian troops, in the face of great prejudice and opposition. He found out that it was in vain to fight the Russians without soldiers like theirs; that artillery could only be opposed by artillery; and that all his efforts to make an impression upon them, with his undisciplined rabble, had uniformly been unsuccessful. To overcome prejudice, he himself adopted a soldier's dress and submitted to learn military exercises from a Russian; he commenced with twenty or thirty men at a time, whom he

(1) Voyage en Perse, 1828.

(2) Persia and the Persian Question, Vol. I, p. 572.

(3) Ker Porter, Travels in Georgia, Persia, Armenia, &c., 1821.

caused to be drilled in a separate court by themselves, in order that they might not be exposed to the ridicule of the populace.(1)

The tributes paid to Persian military prowess in books on Persia, published in the early part of the nineteenth century, are so numerous that only the briefest summary can be attempted. These tributes are recorded in almost all cases by military officers as the result of personal experience.

The Gardanne mission of Buonaparte proved shortlived and a failure, and the prosecution of the experiment of producing an organised and disciplined Persian army passed into other hands. But, before examining the results of the experiment upon the patient Persian, it will be of much interest to note what, in the view of our twentieth century writers, was the character of the human material with which the professors of European army methods and tactics had to deal.

Says Sir John Malcolm :(2)

> " As a nation, the Persians may be termed brave : though the valour they have displayed, like that of every other people in a similar condition of society, has, in a great degree, depended upon the character of their leaders and the nature of those objects for which they fought."

Elsewhere he writes :

> " The irregular horse of modern Persia are the same kind of troops which opposed the Romans ; and they have preserved not only the habits, but the mode of fighting of their forefathers. As the men are robust and brave, and their horses active and strong, there cannot be a cavalry more suited for all the purposes of predatory warfare." (3)

Of their skill in horsemanship Ker Porter(3) speaks in high praise :

> " A Persian has the reins put into his hands, almost as soon as he quits his cradle, and mounts the most spirited animals, at the age when our boys are just bestriding a rocking horse......When we talk of fiery steeds, in this country, the term carries no comparison with what may bear that name in Europe. These are, indeed, horses of the sun ; beautiful and fleet, and often fierce as the burning element......these words are something more than a metaphor."

Waring(4) notices the surprising length of the Persian marches—forty or fifty miles a day ; on urgent occasions " at the rate of seventy miles for three day days together," without baggage. As to the capacity of the Persian soldier for long marches, Sir Henry Rawlinson once took the trouble to calculate the distance travelled daily in all the marches of Abbas Mirza. The total distance he traversed was about 2,500 miles, and the average distance of each day's march was 21½ miles. " It is," he says, " perfectly unique in military history to find a march of 2,000 or 3,000 miles performed by an army of regular troops at the rate of 21½ miles per day. His powers of endurance are, in fact, quite extraordinary."(5)

(1) Morier, A Second Journey through Persia, &c., 1818.
(2) The History of Persia, 1815, Vol. II, p. 637.
(3) *Op. cit.*, p. 496.
(4) A Tour to Sheeraz, 1807.
(5) J.R.U.S.I., 1858.

Elsewhere Sir Henry says:

"The Persian, considered as a mere animal, is so very superior to any other Asiatic—to an Indian, or a Turk, or even a Russian—that it is impossible to avoid foreseeing that, as any European war becomes developed in the East, the military resources of Persia must be called into action. In fact, it seems we could not have a more formidable engine of attack and offence launched against India than a Persian army commanded by Russian officers. In the same way, we could not have a more efficient engine of defence than the same army led by British officers, or by officers acting in our interests."

Speaking of the nomads in particular, Morier(1) tells us that:

"As raw material for soldiers, nothing could be better than the Eelauts. Accustomed from their infancy to camp life, habituated to all sorts of hardships, and to the vicissitudes of weather, they have undertaken incredible marches without scarcely any food, and without a murmur. In such qualities they will, perhaps, equal any troops in the world, but they are greatly deficient in the soldier's first art, the art of dying. Accustomed to their old mode of fighting, where every man, independent of the other, first took care of his own safety before he thought of killing his enemy, they did not relish our system......Their ideas of courage are indeed totally different from ours."

In answer to Morier's opinion that Persian soldiers "are greatly deficient in the soldier's first art" (*i.e.*, the art of dying), Sheil,(2) who was one of the detachment of officers sent by the Government of India for the drill and discipline of the Shah's army, says:

"In this sarcasm Mr. Morier seems to me to have done great injustice to the profession of arms in Persia. No irregular troops, whether they be native, Persians, or Koords, Arabs, Afghans, Toorkomans, or Turks, are able to contend with the disciplined Persian forces. The *Nizam* (3) of Persia and Turkey have never yet met; but in the last contest between these two nations, three or four thousand Persians of the regular army put to flight thirty or forty thousand Turks at Toprak Kalla, between Bayazeed and Erzeroom.

"The Persian soldier is active, energetic, and robust, with immense power of enduring fatigue, privation and exposure. He is full of intelligence, and seems to have a natural aptitude for a military life. Half clothed, half fed, and not even half paid, he will make marches of twenty-four miles day after day, and when need be he will extend them to forty miles......Unlike a sombre apathetic Osmanli........the Persian soldier is full of life and cheerfulness."

"A Persian," he further says, "is sometimes called the Frenchman of the East, from his intelligence, his quickness, his social qualities, and to these may be added the same aptitude for arms which distinguishes the Gallic warrior. Though he never attains the wonderful precision of an English soldier—I doubt if he ever could—he has a very satisfactory readiness in comprehending and attaining the really essential points required in a regiment of infantry."

As a final tribute, were further tribute needed, to the qualities of the material composing the Persian fighting element, I quote at length that of a more recent

(1) *Op. cit.*

(2) Glimpses of Life and Manners in Persia, 1856, by Lady Sheil. With Additional Notes.

(3) Disciplined troops.

writer, the observant Dr. C. J. Wills,(1) who views his subject with the critical eye of the medical practitioner:

"The country is the finest recruiting ground in the world. English officers of the practical type have frequently asserted that material for making some of the finest soldiery in the world is to be found in Persia. The Persian soldier is brave, active and hardy. His physique is magnificent, and his power of endurance great. Upon dry bread, with an occasional bit of cheese, or a basin of curds, the Persian will think nothing of marching his thirty miles a day, for days in succession. And the Persian soldier, if not perhaps as tall as our ordinary linesman, is as heavy and as strongly built. Only feed him and pay him, and the Persian sepoy, essentially a mercenary, will be as faithful to his colours as any soldier in Asia. So much for the infantry.

"As for the cavalry, as irregulars they are probably the finest in the world. No rocky pass is too steep, no march too long, The Eeliauts, or wandering tribes such as the Bakhtiaris, Kashkais, etc., can supply their fearless horsemen in tens of thousands. Why are the Government cavalry in Persia so ragged and their poor nags but skin and bone? Simply because they generally get neither pay, forage, nor rations. Start on a fortnight's march of some 300 miles with a Persian horse-soldier or two: at the end of it he and his horse are the picture of health and condition. And why? Because they have been fed. We talk of the Cossacks. Three years ago the Shah had three Cossack-dressed regiments, drilled by Europeans and regularly paid; a finer body of men and horses it was impossible to see.

"In truth the Persian is no fine weather soldier; nor is he a mere fighting machine. Hardy and of powerful physique, he is at the same time very intelligent, amenable to discipline, sober, and ready to follow his officers if he can only trust them. It is the officering that is the worst of it. The cavalry are also very efficient. Their ill-fed horses are always in hard training....The Persian cavalry soldier has been a trained horseman from childhood; and he is usually a good shot in the saddle and on foot."

So much for the material. Could praise, with certain reservations, be higher? And now for the views of the same writers on the results obtained and obtainable. Ker Porter(2) writes very fully on the question and says:

"A plan was digested for the organization of a body of infantry and the establishment of another of artillery......also a certain number of officers and non-commissioned officers, sent from His Majesty's and the Company's service in India, to instruct the new Persian levies according to British military tactics.... The result was very promising; for with regard to the rank and file, there cannot be better material in any country for forming a perfect soldier, than the native Persian; he being strong, active, quick of apprehension, brave, and, when properly managed, sufficiently docile and steady. But as such management is the thing particularly required, to produce the two last essentials in the character and practical use of a soldier; the almost total absence of it for so many ages in Persia will sufficiently account for even her bravest troops having sometimes shewn themselves as little to be relied on as an army of wild animals from the jungle, whom accidents are as likely to scare away as to bring on to their invited prey."

(1) Persia, as it is, 1886.

(2) *Op. cit.*

"As a consequence of training, only a very short time elapsed before a fine body of native soldiers, regularly clothed, armed, and disciplined, appeared in review before the King, in a style in no way inferior to our European regiments of the line. [All were] amazed to see how completely the rude aspect of the nomad and the mountaineer was changed to an orderly deportment; and above all, how soon their fierce unshackled habits of independence had been subdued into the docility of attention, and finally regulated within the restraints of the strictest military discipline. In short, instead of a camp of wild barbarians, they now saw a field of serviceable soldiers.

"The native soldier, from natural disposition and habits, cannot fail being adapted for war in any part of these Oriental climates. He is inured to heat, fasting, thirst, fatigue, in short, privations of every kind, without a murmur. Indeed, his usual moderation is such, that bread, water and a little fruit, dried or fresh, makes a feast for him at any time. These people have been known to make the most unparalleled long marches, without refreshment of any kind...... They are alike patient and active, are anxious to be taught any useful art, and emulous of excelling. When once brought to discipline, no men on earth can be more steady and obedient under arms, and their sobriety is inviolable. This last virtue is of the first consequence in a soldier. Hence when we sum up all these qualifications for a soldier, and this adaptation to climate and its resources besides, it may be seen that were these battalions chiefly officered by Europeans, 50,000 Persians so organised would prove more formidable during a campaign in the East than four times that number of the best European veterans."

But there were obvious limitations to the effectiveness of a trained army in Persia. Of these limitations Sir John Malcolm(1) was amongst the earliest to take note and to express misgivings as to its efficiency. He says:

"The reigning monarch of Persia (Fath Ali Shah) has been disposed to try this system by an observation of the advantages which the Russians derived from their discipline, and a belief that his subjects, if clothed, armed, and trained in the same manner, would be more equal to a contest with that nation; and he, has probably seen with satisfaction the growth of a force, which is also calculated from its formation, to increase his power over the more turbulent part of his own subjects; but it is perhaps, fortunate for his kingdom, that this plan has not yet proceeded to an extent that can have seriously injured either the feelings or the efficiency of that irregular army, to which Persia must (while her Government remains unaltered) trust principally for her defence against the attack of any European power. The means which this nation possesses to resist such an attack are far from inconsiderable; but they are of a character which would not be improved by the partial introduction of a new military system."

Waring (2) detects a flaw in the national character of the Persian; deprived of their natural freedom of action and initiative, they were prone to play for safety. "If," he says, "we were to attend to the natural prejudices of the Persians, we should entertain no unfavourable opinion of the valour and discipline of their troops; but if we estimate their courage by the resistance which they make against victorious troops, or by the losses they sustain, I fear they will greatly resemble the armies of the Italian States, who fought whole days without losing a single man."

(1) *Op. cit.*

(2) *Op. cit.*

Commenting on the conditions in Abbas Mirza's army, J. B. Fraser, (1) writing in 1825, says:

"In attempting to take a view of the military resources of Persia, the reader must divest himself of every idea that can bring to his mind the existence and attributes of a regular army; the King possesses nothing of the sort. The establishment, if such it can be termed, is as irregular as the nature of the conflicts they usually have to sustain; very little controlled by any sort of discipline, and perfectly unattended by anything that could impress a soldier of Europe with the ideas he attaches to the pomp and circumstance of military appearance."

In this time:

"The most efficient troops in the King's (Agha Muhammad Khan) command . . consisted entirely of cavalry, and which, though sufficiently active and hardy, have greatly degenerated from their ancient character for courage and zeal.

"In the days of Nadir Shah the troops of Persia were active, brave and expert in the discipline of that prince; he endured no coward and his men dreaded his frown more than the enemy's sword. Agha Muhammad Khan had likewise the talent of forming good and brave troops. His active and ambitious disposition kept his army constantly engaged; and they acquired a veteran hardihood and expertness, that rendered them superior to any other Asiatic troops. When they were called up to oppose more disciplined legions, he well knew how powerful their efforts might be made, when directed to a harassing and desultory mode of warfare. (2) But it was the genius of these commanders that alone made their troops so powerful. Their continual wars kept alive the military spirit in full vigour: the system has changed with the sovereign. Not only is the present ruler unwarlike himself, but he has taken every possible step to break the national spirit which he found in the country, and to destroy all he succeeded to of an army."

Sheil, (3) speaking with the practical experience of an officer who had participated in the military training of the Persians, makes the following comments:

"If they could not enable the Persian troops to contend successfully with the regular troops of other nations, they at all events gave the Persian artillery and infantry the means of beating an unlimited number of Afghans, Koords, and Toorkmans, or irregular Persian troops."

"The soldiers are drawn almost entirely from the wandering eelyats of Toork and Lek tribes, and from the ordinary peasantry. The eelyats have the reputa-

(1) Narrative of a Journey into Khorasan, in the years 1821 and 1822.

(2) When preparing to attack the Russians in Georgia, Agha Muhammad assembled the leaders of his army and said: "My valiant warriors shall be led against them; and we will, by the blessing of God, charge their celebrated lines of infantry, &c."
He said to one of his ministers, "Can a man of your wisdom believe I will ever run my head against their walls of steel, or expose my irregular army to be destroyed by their cannon and disciplined troops? I know better. Their shot shall never reach me; but they shall possess no country beyond its range. They shall not know sleep; and, let them march where they choose, I will surround them with a desert." Malcolm's History, Vol. II, p. 297f.

(3) *Op. cit.*

tion of being the best soldiers, though, in my opinion, undeservedly. The best regiments are those composed of the above classes indiscriminately."

Of the cavalry, he speaks in high terms of praise:

"If the Persian cavalry has fallen from its ancient fame, it is nevertheless considered more than a match for Turkish troops of the same description, and fully equal to the Cossacks of the Russian army. I have heard that in the last war the Persian horse never shunned an encounter with the Cossacks, above all with those of the Don, though they were wholly incapable of contending with Russian dragoons."

Of the Persian artillery who are termed *Topchis*, Stocqueler (1) writes: "They form a most useful and efficient branch of the army, and have called forth the encomiums even of Russian officers"; and of the comparative value of disciplined Persian, as against irregular troops, he says:

"Of the superiority of disciplined over irregular forces . . . It is sufficient to mention that throughout the war with Russia, they maintained an immeasurable pre-eminence over the undisciplined troops, though badly commanded, in almost every action. At Aberan, where they were led on by a famous chief named Goreb Khan, and others of tried courage, they took fifteen hundred Russians prisoners, and killed and wounded a much greater number. . . . Instances might be multiplied of their steadiness and efficiency under proper training, but these will suffice."

England's participation in the endeavour to create a disciplined army in Persia after the European model, first prompted, according to Sir Henry Rawlinson, (2) "in order to counter Russia," ended, so he says, in dismal failure. It was not that the material was not present. On the contrary, Rawlinson asserts, like so many others, that it was there in abundance.

"One half of the nation," he says, "lives in tents, and the other half lives in houses, and this distinction is much greater than might at first be supposed, because it involves an entire distinction in the way of life. The former are mere shepherds; their life is pastoral, they live by their flocks and herds."

The words might almost be those of Plato that we have quoted:

"The latter are agriculturists. . . . . In general, those who live in tents have summer and winter pastures, and they migrate from the one to the other with their flocks and herds: they derive all their notions of property from their produce. They are a people of particular interest, because they furnish the great mass of men for the Persian armies. They are the fighting class, and as such are of great importance, because they are far superior in all the best qualities, both mental and bodily, to the Persians of the towns. They are comparatively honest, they are certainly brave, and they possess many of the characteristics of the hill or mountain tribes of Europe." (3)

"It can be proved, we think," Sir Henry says elsewhere (4) "that whatever benefit Persia may have derived as far as regards the centralization of the power

(1) Fifteen months' Pilgrimage through untrodden tracts of Khuzistan and Persia, 1832.

(2) J.R.U.S.I., 1858.

(3) England and Russia in the East, 1875.

(4) *Op. cit.*

of her monarch, from the introduction into her armies of European discipline, she has been as a substantive power progressively weakened by the change, and rendered less capable of sustaining pressure from without. . .

"It would detain us too long to explain in detail the seeming paradox of discipline engendering weakness. If it be remembered, however, that when the system is affected with chronic paralysis, the attempt is vain to restore any particular member to a healthy action, it will be understood that to a nation devoid of organization in every other department of government, a regular army was impossible. It thus happened that, notwithstanding the admirable materials for soldiery which were offered by the hardy peasantry of Azerbijan, and the still hardier mountaineers of Kermanshah—notwithstanding the aptitude of the officers to receive instruction—notwithstanding that a due portion of physical courage appertained generally to the men—the disciplined forces of Persia, considered as an army, and for the purpose of national defence, were from the epoch of their first creation contemptible. Beyond drill and exercise, they never had anything in common with the regular armies of Europe and India."

We will now pause for a moment to examine the size and composition of the fighting force which, at successive periods, Persia has had at its disposal. We have no means of arriving at even an approximate estimate of the numbers of the Persian army in the great days; but its strength was undoubtedly enormous—millions are spoken of—in so widely extended an empire as compared with the present-day area. Chardin is the first to give us actual figures, and tells us that the Persian effective army on the death of Abbas the Great was reckoned at 120,000, of whom 50,000 were royal and 70,000 provincial troops, though he gives no clue to its composition or to explain so high a figure.

Chardin's figures are borne out by Sanson, (1) a missionary from King Louis XIV to the Court of Persia in 1683, who estimates the Persian army at 150,000 men (exclusive of the garrisons of the towns in the interior) distributed over the defensive frontier as follows: 12,000 in Kandahar overlooking India, 20,000 watching Balkh and the Tartars, 15,000 by the Caspian, 12,000 for the Caucasus, 20,000 for Circassia, Georgia, &c., 20,000 for Turkmania and Kurdistan, 12,000 towards the Turkish Empire, 12,000 in Luristan, 15,000 in Susa for Arabia, and 12,000 for the littoral from the Persian Gulf to India. Scarcely any of these, he tells us, were foot soldiers, "because they could not support the fatigue of many deserts and mountains; and artillery was little used for the same reason."

With the decline of the Safavi dynasty marched *pari passu* the decline of the army and, so bad did things become that, when the observant Polish Jesuit, Krusinski, (2) was in Isfahan during its siege by the Afghans in 1722, though there were, he tells us, some 400 pieces of cannon mounted at various places, each of which discharged at least 400 times, they were so badly served that not four hundred Afghans could have been killed by them. From the ruins of the decadent Safavi dynasty of Persian Kings arose that great con-

(1) Estat present du Royaume de Perse, 1694.

(2) Histoire de la dernière Revolution de Perse, Vol. II, p. 185f.

queror, Nadir Shah; the essential leader appears and instantly, under his leadership, the army perform great feats. To cite an instance: the Abdali Afghans were preparing with 30,000 horsemen to move upon Meshed. Nadir met them with 12,000 of his horse and gained a signal victory in spite of the great odds. We have noted Hanway's computation of 200,000 men in Nadir's standing forces, composed to a great extent of Kurds, Kajars, Bakhtiari or Afghans; it was the leadership and the choice of the material which mattered—not the numbers.

Under Fath Ali Shah (1797-1834), again, a high state of efficiency in the army was attained. Sir John Malcolm (1) divides the force then into " a considerable body of irregular horse, furnished by the military tribes of the country, and commanded by their own chiefs; a numerous irregular militia, raised and supported by the provinces and principal cities of the empire; and a corps of infantry and artillery clothed and disciplined in the European manner." The first retained the habits and mode of fighting of their forefathers, using, however, a carbine instead of a bow and arrow; robust and brave, with strong active horses, they formed a cavalry thoroughly suited to the predatory warfare of the country. Fath Ali, like Nadir, was strong enough to compel to his service contributions of the chiefs of these fighting tribes. The militia, said to have exceeded 150,000 men, was composed of men of wandering tribes and inhabitants of towns and villages. Maintained by the province or community to which they belonged, they were liable to be called up when required, receiving at such time pay from the State, but providing their own arms—usually a matchlock, sword, and dagger, and clothing—they obeyed their own officers, but none besides; no machine-made officer could exercise any control over these.

We now come down to the period of tutelage by European officers, when Abbas Mirza, the heir apparent of Fath Ali Shah, anxious to present something like a creditable front to an antagonist from the north, resolved to introduce European drill and discipline among his soldiers. Lindsay of the Madras army, Christie of the Bombay army, Hart, Sheil, to mention only a few English names, succeeded by their exertions at different times in working wonders on the various branches of the service—artillery, infantry, cavalry—not to mention similar efforts on the part of officers of other nationalities. Of the efforts made by English officers, in particular, Colonel Sheil (2) himself records the following:

> " Major Christie was a man of considerable military endowments; he was killed at the battle of Aslanduz in 1812. His able successor was Major Hart, of the Royal Army. Under the auspices and indefatigable co-operation of Abbas Meerza, by whom absolute authority was confided to him, he brought the infantry

(1) *Op. cit.* Vol. II.

(2) Glimpses of Life and Manners in Persia, by Lady Sheil—see, Additional Notes by Sir Justin Sheil.

of Azarbijan to a wonderful state of perfection. The artillery was placed under Lieutenant Lindsay, afterwards Major-General Sir H. Lindsay. This officer acquired extraordinary influence in the army, and in particular among the artillery. He brought this branch of the forces in Azarbijan to such a pitch of real working perfection, and introduced so complete a system of esprit de corps, that to this day his name is venerated, and traces of his instruction still survive in the artillery of that province, which even now preserves some degree of efficiency."

Abbas Mirza died in the life-time of his father; Fath Ali Shah did not long survive him; he was succeeded by Muhammad Shah. Anglo-Persian relations changed and the work of training was quite worthily carried on by officers of other nationality in succession. But the cumulative effect of all this training was disappointing: internal discipline became lax; even parades were perfunctorily performed; the cavalry gradually lost its ancient repute, since the creation of the *nizam*, to the prejudice of the tribal system. And the cause? Some suggest the want of the inspiring commanding leader of the earlier days; others, that the material was not drawn from the same sources; others, the irregularity of pay. The latter shortcoming may be illustrated by an anecdote of Fath Ali Shah who, when speaking to a foreign minister who had complimented him on the appearance of some of his regiments, replied: "Yes, they are excellent, and better still, though they have been three years without a fraction of pay, they never ask me for arrears."

Yet in the sixties of the nineteenth century, according to Mr. Robert Grant-Watson (1) for some time attached to H.M.'s Legation at Tehran, we gather that the army, in spite of various disabilities, still continued to make a good show.

"The military force of Persia," he says, "consists, in theory, of a hundred thousand men, infantry, cavalry and artillery. The cavalry is nearly all irregular, and is in general only called on for local service under the chiefs of the particular district where it is raised. The Shah's body-guard consists of two regiments of regular cavalry, of about 800 men each, more or less. There has been lately raised another small troop of body-guards known by their accoutrements of silver. The irregular cavalry are variously habited, according to the custom of the country whence they are drawn. One small troop in Kurdistan is clad in mail and complete armour. There are about 5,000 artillerymen in the Persian army, and this branch of the service is by no means badly organised. It is their artillery that gives to the Persians the advantage in their contests with the Turkoman tribes."

Mr. Watson's opinion of the material was most favourable, but he condemned the prevalent system under which they worked—pay always in arrears and, when issued, reduced in amount by the exactions of the distributing officers, even from the highest grades downwards, lack of ability in the command, and the general unpopularity of the service for these and other reasons.

Coming nearer to our own times we may, in conclusion, give the views of an

(1) A History of Persia from the beginning of the Nineteenth Century to the year 1858. (1866.)

authority [1] who had exceptionally varied experiences of Persia and the Persian people during a long period extending from 1865-72, and will then leave the reader to form his own conclusions on the military potentialities of Persia, having said enough, I think, to lead him to judge them, given the right conditions, as being of no mean order. In substance, he was of opinion that the marching power and endurance of the *sarbaz* was wonderful, and though better food might in some respects improve his physique, his frugality was such as to account in some measure for his bodily strength. With good officers and good training the Persian soldier might be made very efficient. If wanting in the discipline considered in this country as essential to the well-being of the service, the fault was that of his superiors, by whom he was ill-commanded, ill-taught and ever accursed with an evil example. The moral value of the soldier, according to our authority, deteriorated as the social grade improved—promotion even to the rank of non-commissioned officers, becoming "the first step to demoralization." Remedy these defects, he says, and Persia "is so far important as a military power and military ally that she has, with all her misgovernment and shortcomings, great resources for a powerful army."

Withal, in the operations of the Anglo-Persian campaign of 1856-7, it is true, the Persian army is recorded to have made a sorry spectacle. At Mohammerah, Hunt[2] says: "the army seems literally to have vanished . . . at the last moment all courage had deserted the foe . . . . Their army fled, although the odds were greatly in their favour." But the question before us is not whether any section of an organized Persian army, but without long tradition behind it, was a match for a body of picked European troops with the finest equipment then available; but whether or no, the Persian soldier inherently possesses those attributes which, given the essential leadership, go to make up a doughty fighter. The answer can scarcely be in doubt, with the weight of evidence before us. The country does possess fighting elements of no mean order which, if rightly selected and given the right supreme leader and officers, go to make up a formidable force. The case is well summarised by Colonel Drouville [3] who had a share in the successive efforts made to form a disciplined Persian army, and who, himself, according to Porter,[4] brought a body of regular cavalry to a considerable degree of discipline as lancers. The Persian people, he says in effect, have been distinguished from time immemorial by an eminently warlike character; history bears this out, and even the Romans were not always happy in their contests with them—Valerian was taken by Shapur I, and the Emperor Diogenes Romanus fell under the heel of Alp Arslan, whom he had defied. Persia has had, like almost all the nations of the world, her epochs of glory, and whenever she has been ruled over by a warlike king, she

(1) Major-General Sir Frederic J. Goldsmid.
(2) Outram and Havelock's Persian Campaign, 1858.
(3) Voyage en Perse, 1828, Chaps. XXXII-XXXVII.
(4) *Op. cit.*

has shaken herself free of the apathy which is, in a way, natural to her character, and which has so often been the root cause of her failures.

The principal arm of Persia, he goes on to say, now consists, as with all Orientals, in cavalry, and there are few men who can pride themselves more in the use of the sabre than the Persians. The Persian army is more or less strong according to the enemy with which it has to deal. Towards the Turks they show no fear. Persia could, if need be, dispose of more than 30,000 Kurds, who are certainly not their worst troops.

Time does not permit of inclusion within the scope of this paper of any reference to that fine body of men, the South Persia Rifles, or the somewhat similar organisations which were started during the war under British auspices in Eastern and North-western Persia. It is sufficient to say that the experiment of enlisting Persians and training them for the maintenance of order in their own country was carried out by selected British officers, drawn for the most part from the Indian Army, with entire success. The most pleasant relations existed throughout between the Persian officers and men and their British instructors. The exigencies of post-war politics necessitated the break-up of this corps, but it is satisfactory to know that a large proportion of the officers and men who received their training at Shiraz and elsewhere, under British officers, are incorporated in the new National forces of Persia and are held in high esteem by their colleagues. Their martial qualities have at no time been in dispute, and the experience of Sir Percy Sykes, Colonel W. A. K. Fraser and others, between 1916 and 1920, proved once more that the claims of British officers, during the early part of the last century, that Persians were capable of subjecting themselves to discipline and of being welded into a formidable fighting machine, were fully justified.

DISCUSSION.

The Rt. Hon. Lord Lamington, G.C.M.G., G.C.I.E., said that from time to time audiences in London had been delighted and instructed by addresses given by Sir Arnold Wilson. The lecture they had heard that afternoon was not any exception, and they had all enjoyed and learned a great deal about Persian life and character.

The main theme of the lecture was that in olden days, in the Middle Ages, as well as in recent times, provided that they were properly led, the Persians were undoubtedly a race of great valour and courage. Ample testimony for that had been quoted by Sir Arnold from Sir Henry Rawlinson and other authors, who had had great experience of the Persians. He (the speaker) was not a great admirer of the cinema, but he was compelled to say that the film they had been shown was one of the most marvellous he had ever seen. There was no possible fake about it. One could fully believe that when whole tribes could undertake an arduous mountain journey of that description, there must be great latent courage in every man, woman and child. Under the firm guidance of H.M. Riza Shah Pahlevi, they quite believed, as Sir Arnold Wilson had told them and as he understood from others, that there was going to be a great renaissance in Persia, and that Persia would once

again take her position among the nations of the world. He was sure they hoped that that would be so, not only on account of Persia herself, a country of wonderful historic interest, but also because, in his opinion, a strong independent and friendly Persia was one of the great safeguards to their Indian Empire. Having said that, he would make just a few references to the picture they had seen. One reflection which probably came into the minds of most of them there was that when we talked of a living wage and the starvation line in our modern industrial civilisation, we should ask ourselves what real meaning those words had when one looked at the actual facts of human beings battling with Nature in her sternest moods, as shown in those pictures. Were we not guilty of exaggeration? Perhaps another reflection might be permitted: Was it possible that they were too dependent upon the luxuries of present day civilisation, when the luxury of to-day was the ordinary comfort of to-morrow? Was not it possible that in future generations Nature might re-assert herself? They must be careful not to become slaves to all these luxuries which were called comforts, or, it might be, other more vigorous peoples, now cradled in the great waste places of the earth, might assert themselves successfully against races grown too dependent upon what they regarded as the necessities of civilisation. That was only a passing reflection, and had no immediate connection with the purport of the lecture.

He would not detain them any longer, except to express once again to Sir Arnold his deep appreciation of the lecture, and for having imparted to them something out of the vast store of information which he possessed on everything relating to the Middle East.

Dr. A. R. Neligan said he had just returned from Persia after a long residence there, the last five years of which had coincided with the reorganisation of the Persian Army. He was not qualified to say anything about the past history of the Persian Army, which Sir Arnold had so well described, but he would like to ask him one thing. Was it not an historic fact that the very tribe which they had all seen migrating on the film, was the only one victorious over Alexander, or, at any rate, over one of his generals?

Passing to the reorganisation of the Persian Army, its appearance and discipline had been greatly improved. The drill, as any of the Europeans living in Teheran who took early rides saw, was of a most intensive description. Every morning the troops rose before daybreak, and shortly afterwards were drilling. He could assure them he had seen Persian troops being drilled in the month of Ramazan, which was the month of fasting, in the afternoon —and that was in the hot months of summer. The young officers in Tehran presented a most pleasing appearance. They were smart, they were good horsemen, they were well-drilled. It was interesting to see the Persian cavalry on their sturdy ponies. Marching, as had been said, and as British officers had often said to him, was one of the outstanding qualities of the Persian infantryman. The re-organisation was due to H.M. Riza Shah Pahlevi. They had all read in the press the description of how he had risen from being a trooper to the position of Shah of Persia. He was a patriot of patriots. He had great energy. When he was Minister of War he used to visit the Ministry at 7 o'clock in the morning to see whether the officials were on duty. A law enforcing military service had recently been passed by the Persian parliament. Officers of all arms including air pilots and medical officers were being trained in France or Russia and motor transport, caterpillar tractors, armoured cars and aeroplanes had been introduced. It was quite true that

Persia had entered on a period of prosperity, and none wished her success in her future years more heartily than Englishmen. The beautiful film that they had seen must have filled more than one in that room with memories of wonderful days passed in the Persian mountains. It showed what manner of man the Persian tribesman was, and what manner of soldier could be made out of him.

LIEUT.-COL. SIR ARNOLD WILSON said in regard to the question whether the people of the Bakhtiari country (the Uxians) were successful in resisting Alexander, history was somewhat vague. They had it only from Alexander's point of view. According to Quintus Curtius,(1) they defied Alexander, but he claimed that he resisted and passed victoriously. As the route followed by Alexander showed a detour in the vicinity of the Bakhtiari, one might well believe that Alexander thought discretion in that case was the better part of valour.

Dr. Neligan made a very interesting reference to the intensive campaign of drilling going on in north Persia. He (the speaker) could not speak as to that, but there was also an intensive campaign of drilling in south Persia with which he was better acquainted, and it was largely conducted through the assistance of these very fine tribesmen. He could further say that they were just as good on the oilfields as they were on the parade ground. The Anglo-Persian Oil Company had been established in the Bakhtiari country for the best part of 18 years and, during the whole of those years, they had conducted their operations with labour largely drawn from the Bakhtiari tribe. He could speak from a continuous knowledge running back to 1907, and on no single occasion had they ever had serious trouble of any sort. They were good workmen. When the Company first came, very few of them had ever seen a motor car, much less an internal combustion engine of the type used in the workshops. During the last 10 or 12 years they had been able to train Persian tribesmen to do almost any sort of skilled labour. If the power of initiative of the Persian tribesmen generally was as notable in the military sphere as it had been in their workshops, he had very little doubt indeed that Persia had a great future, both military and economic, before it. That concluded his remarks, and he could only say it had been a very great pleasure to bring the film before such an appreciative audience.

The CHAIRMAN said that Sir Arnold Wilson had referred to the South Persia Rifles which he had had the honour to raise and train during the War. He must say that under the command of British officers they did extraordinarily well. When they were disbanded some four years ago, Colonel Fraser, who then commanded them, wrote to him (the speaker) the most heartbroken letter he had ever received. Colonel Fraser thought it was the most trying thing in the whole of his life to say "Good-bye" to his men. However, as a result of the whirligig of Fate, Colonel Fraser was now Military Attaché at Tehran, and he had a letter from him a few days ago in which he said most of his trained officers and men were holding good positions in the new Persian Army. He also told him that the Polo Club which he started at Tehran 29 years ago was still flourishing, and that the best players were the men from the South Persia Rifles, so that that bore out what Sir Arnold Wilson had said. They were a fine body of men. The upper class of recent years had certainly become effete, and they were not fighting men, but a revolution had taken place which, as in the days of Nadir Shah, had brought the fighting men back to their position of dominance in the State, which was as it should be.

In conclusion, he would like on their behalf to propose a hearty vote of thanks to Sir Arnold Wilson and also to the intrepid makers of the film.

The vote of thanks was carried with acclamation, and the meeting terminated.

(1) The History of Alexander the Great, lib. V. cap. III.

NOTES ON BOOKS.

THE ENGLISH BRASS AND COPPER INDUSTRIES TO 1800. By Henry Hamilton. With illustrations. London: Longmans Green and Co. 18*s*. net.

This lucidly written and well illustrated book of XXVII+388 pages is not intended to be an exhaustive treatise on the chemistry and physics of brass and copper; it being in the main a study of economics as elucidated by the industrial events of the second half of the sixteenth century and their consequences on to 1880. After the Armada a war party was in opposition to a party for peace and rehabilitation. Robert Cecil, who became Queen Elizabeth's Secretary of State in 1597, was emphatically for peace and rebuilding: his strong, diplomatic, but unobtrusive hand being traceable all through the parliamentary sessions 1597-1601. These sessions are touched on briefly by the author (p. 43), but with a general recognition (p. 42) of the good policy of the previous half century or so in establishing the copper and copper-alloy industry on the best available basis, that is to say, technics, workers and capital from Germany. The story from 1543 forward, which shows us how organised capitalistic production arose in England, runs from p. 6 and is continued to the end of the chapter on "The Beginnings." Here we have a study of the somewhat contrasting policy of the two Cecils; moreover, the reader who has studied this chapter will realise the old adventurous spirit of crusading, as having been revived and expended upon commercial and colonising enterprise across the seas.

Those most profound in their studies of political economy will find abundance in the work under notice to engage their attention and to stimulate them to new thoughts, and reference may be made to p. 112, and pp. 303-304, which are two of many cases in which protective import duties are touched upon; here, for example, as regards proportional fairness to the various industries, and the influence of protection on quality. The incidents of the competition phase are noted on pp. 329-330; while on p. 328 will be found some matters for thought as to the dangers of extensive commercial privileges and the abuse of legal monopoly. The ideas and agitation which paved the way for the patent law of James I are considered on p. 43. Abundant foot notes, mostly references to original authorities, make the work complete as an economic treatise.

Many parts have special interest for the technician and the laboratory worker, as, for instance, the account of the old method of preparing brass from copper in which zinc vapour penetrates the hot but unmelted copper, the copper thus absorbing about half its weight of zinc, pp. 339-341.

The interest and quaintness of the eight inset illustrations will attract the general reader; moreover the wording of the text is so clear and pleasant that the general reader is not likely even to suspect that he is being instructed in that which is sometimes so inappropriately called the dismal science, unless in glancing at the title page he notices that our author is lecturer in economic history in the University of Aberdeen.

GENERAL NOTE.

THE INSTITUTE OF METALS.—The autumn meeting of the Institute of Metals will be held in Liége from September 1st to 4th. An attractive programme has been arranged, including official receptions, lectures, visits to works, and excursions to places of interest in the neighbourhood. Particulars can be obtained from the Secretary of the Institute, 36, Victoria Street, S.W.1.

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FRIDAY, JULY 23rd, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

COUNCIL.

A meeting of the Council was held on Monday, July 12th. Present:— Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Sir Frank Baines, C.V.O., C.B.E.; Captain Sir Arthur Clarke, K.B.E.; Sir Archibald Denny, Bt., LL.D.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Sir Edward A. Gait, K.C.S.I., C.I.E.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Col. Sir Arthur Holbrook, K.B.E., M.P.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Sir John O. Miller, K.C.S.I.; Sir Richard Redmayne, K.C.B.; Sir George Sutton, Bt.; Mr. Alan A. Campbell Swinton, F.R.S.; and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary).

Sir Thomas Holland was unanimously re-elected Chairman of the Council for the year 1926-7.

Arrangements were made for the presentation of the Society's Albert Medal to Professor Paul Sabatier by His Royal Highness the President on July 22nd.

The Chairman was authorised to nominate a Committee for the purpose of making preliminary arrangements in connexion with the question of the Preservation of Ancient Cottages. Sir Frank Baines was appointed Chairman of the Committee.

A report from the Examinations Committee, recommending the institution of a series of Group Examinations, mainly intended for Central and Day Continuation Schools, was considered and approved.

The various standing committees of the Council were re-appointed.

Papers and courses of Lectures for Session 1926-7 were considered.

Other formal and financial business was transacted.

COMPETITION OF INDUSTRIAL DESIGNS.

The work submitted at the Annual Competition of Industrial Designs was received at the Imperial Institute, by kind permission of the Board of Governors, at the end of June. The judges in the various Sections examined the work on various dates between July 12th and 21st. The selected designs are now being hung, and the Exhibition will be open to the public in the Upper East Gallery of the Imperial Institute, South Kensington, from July 31st to August 31st next, every weekday from 10 a.m. to 5 p.m.

The Exhibition will be open free of charge, no tickets being required. It will include Designs in Architectural Metalwork (Shop Fronts, Lift Enclosures, and Window Frames), Wallpapers, Textiles, Furniture, Printing and Book Production, China, Earthenware and Glass, as well as Designs for Posters, Showcards, Exhibition Stands, Chocolate Boxes, Lay-outs, Price Lists and Endpapers submitted for valuable prizes offered by a number of well-known firms.

A bureau of information will be established at the Royal Society of Arts in connexion with the Competition, at which will be kept the names and addresses of exhibitors who desire to obtain employment as designers. These lists will be at the service of manufacturers in search of designers.

A report on the Competition, including full lists of the awards, will be published in the *Journal* at an early date.

PROCEEDINGS OF THE SOCIETY.

SPECIAL MEETING.

THURSDAY, JULY 8TH, 1926.

SIR RICHARD REDMAYNE, K.C.B., late H.M. Chief Inspector of Mines, in the Chair.

THE CHAIRMAN apologised for being a little late in opening the meeting, but he had been waiting for about one hundred members of the audience who were anxious to come from the House of Commons to hear Mr. Hodges deliver his paper. It was customary at these gatherings for the chairman merely to introduce the speaker and then subside. On this occasion he had the greatest pleasure in introducing a very old friend, Mr. Frank Hodges, a friend of twenty years' standing. Mr. Hodges was well qualified to speak on a number of aspects of the subject of his address. He was the able and distinguished secretary of the Miners' Federation of Great Britain for a number of years. He then entered a place called the House of Commons, and distinguished himself there, and became in the last Administration a Civil Lord of the Admiralty—no doubt, because of his knowledge of coal. His appointment, however, did not result in any great increase in the use of coal in the Navy; rather did the Navy go in more for oil. Recently Mr. Hodges had accepted the position of Secretary of the International Miners' Federation and therefore he was well qualified to deal with his subject from the international point of view

The following address was then delivered :—

THE ECONOMICS OF THE COAL INDUSTRY.

By Frank Hodges,

Secretary, International Miners' Federation.

I am glad to have this opportunity of speaking to the Society under the presidency of Sir Richard Redmayne. His authority in, and influence upon the coal trade of Britain are unquestioned, although like others of us, he has not escaped condemnation when he has made practical proposals for the benefit of the industry which are a departure from the conventional practice adopted by it. Woe unto those who break the bonds of the propaganda formula, whether of one side or the other! It is a consolation, however, to know that there is a large and now growing number of men who have convictions of their own based upon a knowledge of the facts of the industry, and who have courage to express them upon the public tribunals of our country, regardless of the consequences to their personal well-being and interest. Much of the misery which has fallen upon the miners and their families and upon the workers of the country is due to the flight from fact on the part of those whose special business is to know the facts of their industry and to shape their industrial policy in harmony therewith. Legitimate though it be to pursue a policy which has for its object the steady improvement in the economic and social conditions of the workers—this being the *raison d'être* of Trade Unionism—such a policy must always be in relation to the actual and known possibilities or potentialities of industry. Generalisations, *démagogie*, declamation, are but poor substitutes for knowledge, and they bring in their train a terrible nemesis when employed by those upon whom rests the responsible task of leadership.

The Royal Commission laid bare many of the hard facts of the Mining Industry. They were startling in their character and were presented in such a form that all who ran could read. To those who were acquainted with the economics of the industry, the Commission's Report did not come as a surprise, but a surprise was in store for those who expected the Report to be adopted by the parties concerned. The refusal of the Miners' leaders to accept the Report with all that it implied, will be recorded as the greatest error of Trade Union history. I did all that one man could do to influence opinion in the direction of accepting the report immediately it was published, but the opportunity passed by, never to return in its old form. Each offer or opportunity which has come since, has been less favourable than its predecessor, and so on to the end, because those who make them are conscious of the steadily worsening effects upon the economic facts of the industry, caused by the prolonged stoppage of production. For the moment there are no economics of the mining industry, for there is no industry. But the future economics of mining are being im-

perceptibly, but inevitably influenced by the economics of mining in the world outside.

What was our position in the world before the stoppage began, as revealed in the Commission's Report? The coal exported in 1909-1913 was 88.37 million tons, in 1924, 81.75 million tons; and in 1925, 68.97 million tons, showing a reduction of 22 per cent. The value in 1909-1913 was 12/2 per ton; in the June quarter of 1925 it was 20/7; in the December quarter of 1925, 18/5, while in April 1926, it was 17/6¾. You will therefore see that there was an increase for the month of April over the prices for 1909-1913 of 44 per cent. The loss of twenty million tons of export coal has the triple effect of decreasing the amount of employment in the mines, of decreasing the volume of shipping between this country and the rest of the world, and increasing the cost of living by decrease in the homeward cargoes of the necessaries of life which would have come to this country had the twenty million tons been sold. The fall in exports has been attributed in the main to a world depression, an excess of supply over demand, development of coalfields in countries hitherto undeveloped, the increased use of oil, lignite and water, for the production of power.

A question of most vital importance arises here, and that is whether Great Britain is sharing proportionately with other countries the loss of exports. German exports in 1925 were at the rate of thirty-five million tons, whilst in 1909-1913 their exports were at the rate of 27.7 million tons. The German exports, therefore, have increased by 7.3 million tons in this period, whilst British exports have decreased by twenty million tons. The exploitation of lignite in Germany to the extent of nearly 140 million tons per annum, equivalent to about 38 million tons of bituminous coal, has increased the quantities of fuel available for home consumption, and has made possible the release of export coal for the markets of the world at prices which have enabled the coal to be sold in markets which were essentially British, and which at the moment are lost to Britain. In the case of France, Italy, Denmark, Scandinavia generally, and Belgium, the internal consumption of coal has increased since 1913, whilst the internal consumption of coal in Great Britain was less in 1925 than in the period 1909-1913 by nearly two million tons, and, as compared with 1913, showed a reduction of 9.7 million tons. Taking the general position of Great Britain and comparing it with the rest of the world, British production in 1925 is estimated to be 22.2 per cent. of the world production, whilst in 1909-1913 our average annual production was 25 per cent. of the world's total production, whilst the British coal consumed outside Great Britain was 7.4 per cent. in 1925 as against 9.8 per cent. in 1909-1913. In other words, consumption outside Great Britain was increased by 4.7 per cent. as between these two periods, whilst the consumption of British coal decreased by 2.4 per cent.

Such are the facts of the export trade as revealed to the world in the Coal Commission's Report, and we cannot escape the conclusion, unpleasant though it be, that Great Britain has lost both relatively and absolutely in the coal

business of the world. There can be but two explanations of this, and they are: the lower prices of other competing countries for such market as exists, and secondly, the limitation of that market by the production of coal in countries whose coal measures have hitherto been undeveloped, and who now meet wholly or partially their home requirements from home production. Whilst oil, lignite and water power have added considerably to the world's power supplies, the world production and consumption of coal in 1925, as compared with the five years 1909-1913, have increased. They have undoubtedly dislocated the normal distribution of coal in the world, though they have not decreased its use. As the use of oil in the first period of its commercial career would naturally affect the country whose industrial life is bound up with its marine trade much more than a country whose trade was for the most part internal, it was inevitable that Great Britain should suffer most from the application of oil for power in the Mercantile Marine and the ocean passenger traffic of the world. It is undoubtedly the case, but the prime element in determining the change over from coal to oil is one of price, although undoubtedly a secondary element enters into consideration when shipowners are considering the building of the great ocean liners. It is consideration of efficiency, cargo, space, bunker space, reduction of labour costs and general convenience. I hope to point out later in this paper that, as science develops and becomes more intimately applied to the use of coal, those coal producing countries which have hitherto lost heavily in the bunkering business of the world, need have no cause for alarm at the threat of the displacement of coal by foreign produced oil.

I said a moment ago that our own internal consumption of coal had decreased as between 1925 and 1909-1913 by nearly two million tons, and, as compared with 1913, by 9.7 million tons. This is undoubtedly due to the decline in the general production of Great Britain, caused by her inability to dispose of her other semi-finished and finished articles in her customary markets, due in turn undoubtedly to the dislocation of the currency of many countries in the world, and to the general political instability created by the war and the peace. We can therefore come to one of the conclusions which startled the Commission, namely, that in the year 1925 the total output of coal in Britain was only 248 million tons as compared with 270 in the years 1909-1913, a reduction of 22 million tons, or compared with 1913, which had an output of 287 million tons, a reduction of 39 million tons. That colossal reduction is bad enough in all conscience, but the shock emanated from the following fact: whilst 1,000,105 persons in 1913 produced 287 million tons, 1,156,000 persons only produced 248 million tons in 1925. Or comparing 1925 again with 1909-1913, 1,048,000 persons produced 270 million tons as compared with the last figures which I gave for 1925, namely, 1,156,000 persons for 248,000,000 tons. Or put in another way, comparing 1925 with 1909-1913, there was an increase of personnel of 10 per cent. and a decrease in output of 8 per cent., and compar-

ing 1925 with 1913, there was an increase of personnel of 15 per cent., and a decrease in output of 14 per cent.; that is to say, there are now seven people employed where six were employed before, or in the words of Sir William Beveridge, "You have seven people trying to live where six did before." Not only are we faced with this situation that seven people are trying to live where six lived before, but seven people are endeavouring to live, quite justifiably, better than six lived before.

On the other hand, the employers claim that more capital is in the industry since 1925 than in 1909-1913, and therefore, assuming that the rate of interest remains the same, they expect that the aggregate interest must be greater to meet the requirements of the new capital than was the case before the war, after making due allowance for the natural wastage of capital in the interval. The problem therefore is simply stated: How can an increased number of men get the same or better wages than before, on decreased production, and how can the employers get an increase in their aggregate capital return upon the investment of new capital, also on a reduced productivity? If the price of coal had gone up, or the costs of production had gone down, or the productivity per unit of capital and labour employed had increased proportionately, there would have been no economic problem, though, knowing British human nature to be what it is, I could not say that there would be no political problem.

There, therefore, seems to be an unbridgeable gulf between what is, and what ought to be, and the bridge builders are many and varied. The Coal Commission endeavoured to build such a bridge, for to these the nation had entrusted the task. The Trade Union Congress endeavoured to build a bridge, but their efforts seem only to have evoked the contumely and contempt of those whom the work and sacrifices were intended to benefit. It so happened that the fashion of their building made the position worse, for they weakened the national pillars upon which their bridge was to have rested. Eleven weeks of stoppage of the industry has provided no bridge. This only makes the gulf wider and the task more difficult. The subsidy of 1925 provided no bridge, and in a great fundamental industry of this description it never will provide a bridge. There are those who believe that a general increase in the price of coal would span the gulf, but this can be ruled out at once, for our national industries, nay, our national life, could not stand such an increase as is required to bridge the gap, and most certainly our export trade cannot stand an increase in price at a moment when the price of coal of our competitors is either stationary at our level or tends to fall below it. The existing price for a certain number of collieries that are exceptionally well placed, but perhaps no better managed than many others, might bridge the gap for those who are fortunate enough to possess them, or for those who, by the hazard of circumstances, would work in them. This method has been estimated by the miners' leaders themselves to result in the elimination from the industry of 500,000 men, and not only would the method therefore be a tragedy for half the membership of the Miners'

Federation of Great Britain, but also for that large army of workers in other industries who produce commodities largely dependent upon coal and which have to do battle in the markets of the world for an economic position.

It should be self-evident that that way is not the way, and no bridge is possible there. It becomes self-evident at this stage that a bridge, to be effective, must be one that will give employment to the largest number of men possible, that will yield to them the largest wage possible, that will secure for the dependent industries the maximum advantages possible, and for the industry itself the largest expansion possible on sound technical lines, out of the surplus which it is able to create, and which as long as it is privately owned will attract capital to itself, so as constantly to improve its position in the world of industry. I cannot imagine a single living soul who wants the miners to accept a reduction in wages for the mere sake of seeing those wages brought down. Neither can I imagine that there is a man with a spark of humanity in him who wants to see the hours of the miners increased by a single minute, merely to get them back to the hours before the war or before the Sankey Commission. On the other hand, I cannot imagine any sane man being anxious to exclude from the industry the possibility of making such profit as is necessary to attract the investing public as long as the mines are privately owned. Such an attempt would inevitably strangle all productive effort, and the lot of the nation would get gradually worse.

We are therefore brought to the point in our discourse where we see the last moment economics of the industry and are able to judge quite dispassionately these three important considerations of employment, wages and reason able profit. From what we know of what is happening in the outside world, we can safely arrive at this conclusion, that the longer the stoppage the more certain it is that the capacity of the industry to give employment, diminishes, to give good wages, contracts, and its ability to expand is curtailed. It is true that the imports of coal into this country are a heavy and unnatural burden for the country to bear. It is true that coal miners of other countries in Europe are in agreement with their employers not to send any coal to this country during the stoppage. The Continental miners regard it as an essential of their international obligations to try to prevent the coal coming to England, and it is equally in the interests of the mine owners in other countries not to have a clash with their workmen on this issue. Such coal, therefore, as comes here comes through merchants and factors, who abound in Europe as well as in Britain, and not direct through colliery undertakings. All the while, however, a steady and resolute effort is being made by our competitors to penetrate definitely into our markets, where naturally they hope to remain. In the month of May, as compared with the average monthly figure for January-April of this year, the exports from Germany have increased to the following countries by the following amounts: Netherlands 124,575 tons; Italy 81,000; France 115,000; Belgium 56,000; Algeria 83,000; Sweden 39,000; Spain 56,000;

Argentine 22,000; making a total of 576,000 tons. The total increase in exports, excluding reparation deliveries in the month of May, was 1.8 million tons; a 55 per cent. increase on the monthly average January-April. She has increased her exports to France by nearly four times, more than four times her quantity to Algeria, and has doubled her exports to Belgium and Sweden. Within one month she has been able to supply to Spain more than one-third of the quantity normally supplied by Britain, and one quarter of the usual British quantity to the Argentine. The figures for June will be more alarming still. Make no mistake, the world is not so brotherly, so comradely, as to prevent one nation going ahead with grim resolution to get the advantage whilst another nation is in difficulties. You must take the world as it is and not as it ought to be.

We have another little country on which we must cast an eye, the only other exporting country in Europe, a very polite country and a very courteous country. Polish Upper Silesia must not be excluded from this form of activity in the world markets. In the month of May the Danzig exports amounted to over a quarter of a million tons as compared with the monthly average of 51½ thousand tons in 1925. It is not for us to snivel. They are going on taking advantage of our trouble. The figures for the United States of America are not available. There can be no doubt that they are penetrating definitely with a view to permanence in Brazil and South America generally. To such extent as they succeed will the British mining industry be prejudiced hereafter. A quick resumption of work, however, might yet enable us to neutralise some of the worst consequences to us in the world market. But all this goes to prove my point—the longer the stoppage the greater the difficulty of building the bridge for a resumption of work under reasonable conditions, both as to wages, employment, and development. Whether there had been a stoppage or not, I am convinced that German competition would have made surprising headway in the world. Its hours are longer, its wages are less, and its output is greater. The Ruhr hours are 8 hours for each man, and those of Upper Silesia, in Poland, are 8½ hours for each man. Wages costs in Great Britain are per ton 12/3; in the Ruhr they are 7/10; and in Poland 3/8. The wages of all persons employed in British mines are 10/5; in the Ruhr 7/4½; in Polish Upper Silesia 3/6 per shift.

The latest figure of output per shift in Great Britain was 18.4 cwts.; in Germany 21 cwts.; in Upper Silesia 22.06 cwts. The remarkable feature about the German output is that whilst in 1912 the output per workman per shift, including surface and underground, was 934 kilograms, it has now reached for the month of April the figure of 1,075 kilograms, or an increase of 14 per cent. Great Britain on the other hand, using the same comparison, produced in 1913 1,032 kilos per shift, whilst to-day our output is 937 kilos, or a reduction of over 8 per cent. It is not surprising, therefore, that the losses on production as revealed in the Government statistical summary for the quarter ending March,

1926, show a debit balance of 1/5 per ton for the whole country, ranging from 4/3 per ton in Kent, 3/1 per ton in South Wales, 2/10 per ton in Northumberland, 3/2 per ton in Durham, to a profit per ton of over 6d. in the Eastern area, excluding of course from calculation the value of the subvention.

Now that we have got a fair survey of the economic facts we ought to be ready to begin to make our deductions, and our main deduction must be that if prices cannot be raised at the pit, if wages cannot be lowered, and as there are no reserves of profit upon which to draw for expansion or even maintenance of existing efficiency, we can only turn to the question, which, after all, is the vital question, as to whether the costs of production themselves, can be reduced. If costs of production can be reduced, they can only be reduced in two ways. First, by increased technical efficiency, and second, by increased output per person. In the storms of passion which are now raging in this controversy, it is very difficult to get calm judgment upon this all-important consideration. Unfortunately, there are those in every political party who are prone to submit arguments and make speeches, not so much from the point of view of the welfare of the industry or for the men who are engaged in it, as from the point of view as to how such arguments will affect their fortunes in their constituencies, or how far they will affect the destinies of their particular political party. Happily for the country there are many men whose political or party interests are subordinated to the economic weal of their fellow countrymen. It is to this type of mind that I submit the following consideration.

Technical reconstruction is a phrase that is lightly used and very often misunderstood. It is a well-known fact, however, that technical reconstruction takes time—years, in many cases. It is going on all the time. What we mean by it is, that we want to expedite its evolution. It is limited by the amount of human knowledge available in the technical and economic sense, and when it is available, capital is required for its establishment. In the normal way, an industry creates reserves for its own technical purpose, but if during the next two or three years no surpluses are created, how can there be technical development worth speaking about ? I am not now thinking of profits for distribution. I am thinking of profits for expansion which would have to be provided for under even nationalisation or any other system, unless, of course, it were to become a perpetual burden upon the rest of the community. A curious contradiction is inevitable in business, that unless your industry is creating reserves, or shows some signs of creating reserves, your standing at the Banks for overdrafts and loans, or your appeals for new capital, will be met with a cold and unyielding negative. Sound technical organisation is that form of organisation which yields the maximum output at the minimum cost, and which yields the maximum wages to the individual workman for his maximum effort ; but we must not dissociate technical development in the sheer task of producing coal from the task of producing power from coal. In my judgment no amalgamation would be worth while, and in itself would never bridge the gap to

which I have referred, unless it were definitely linked up with the production of electricity and gas and the recovery of bye-products at groups of mines themselves, which processes hereafter should be an integral part of the coal industry.

The essence of the whole problem is to get something that can be immediately operative in the matter of reduction of costs. Limited trustification will not give it to you. Nationalisation would not give it to you. What might give it to you, though not immediately, would be to start at the beginning to group such collieries as were adapted to grouping on an economic basis—collieries producing two million tons per annum or more. Merely to reduce the number of collieries would not affect the economics of the situation. When you have brought four or five of these collieries together you have not reduced the cost by a single penny. You have to spend capital to reduce costs. In grouping you would want to put up, say, central power stations and plant of all kinds. That involves outlay at a time when there is no capital available. It raises the interesting problem that to begin the process of amalgamation on a large scale you require capital at precisely the moment when you have no capital available and you have no confiding public to give you capital. How, then, are you going to get the public to give you capital ?

That brings up the interesting point of what are the possibilities of security in the industry in the future. If you are to have an agreement that can represent the beginning of technical reorganisation you must always have behind it security. A long term agreement between employers and workmen will give technical development a chance, will give an element of security and will tempt capital into the industry for expansion. If you start on three or six months' agreements or yearly agreements, do you think you can create technical interest and responsibility whether on the part of the Government or private individuals ? You must have at least a five years' period of agreement between the parties in order to win back that confidence which is essential for your technical well-being in the future.

There is another consideration that must not be overlooked. You must never divide in your ideas of reconstruction the producing part of the mines from the use of the coal which is produced. We must bind up production of the raw fuel with the production of electricity and gas and by-products. These things are only transformations of the original fuel and can be transformed at no better place than at the mines, especially when those mines are grouped into such substantially large undertakings as to warrant the expenditure of the equipment of the necessary plant for their production. Where it is technically possible, this gas and electricity should be supplied to the districts locally, and should form part and parcel of the electric scheme of the country, and the profits from the sale of the whole of the gas, electricity and by-products should come into the industry and become part of its finances. Thus you have the elements of a big unified industry. For this you not only want capital, but it pre-supposes that you require brains and to be as free from political interference as possible.

This is a matter for the organisers of our nation, for the technical geniuses of the nation, and if capitalism here and there tends to thwart the progress of science for some mysterious reason, well, it is at that stage that the Government of the day is called upon to brush aside those obstacles and limitations for the sake of giving scientific minds a chance in industry.

All this will take time, but because it takes time it must not be thought to be the least important part of the present problem. It is only the men who have the will to see through the whole difficulty, and have the resolution to act, who ought to handle this problem at the present moment. When you have done all your reconstruction we wonder whether the difference then in the reduced cost will make up the difference between the revenue and cost as indicated by the loss of 1/6 or 2/6 per ton. Our friend, Dr. Stamp, whose words weigh heavily with thoughtful people, had tackled the present problem and the immediate difficulty. He came down in favour of no change in wages. He came down in favour of keeping as many men in employment as he possibly could, and if he had to make a change at all, which was to be purely temporary he could come down to a modification of the hours now operating in the industry. He did not mention the hours to be worked, but if he had he would probably have mentioned eight hours, and at that point I should probably have disagreed with him. I cannot myself conclude that a 48 hour week in Great Britain is necessary in the mines. As international secretary, I can immediately see repercussions that a 48-hour week would have in Europe. It will have no repercussions in America, because they have an eight-hours day at the place where the man works, not at the top of the shaft. It would have repercusion in Europe because it would be the longest working week in Europe. A forty hours week here would be longer than 48-hours week in the Ruhr, as we understand it. The only country with a longer day for miners would be Upper Silesia, and there only a matter of minutes. The Ruhr miner works an eight-hours day, but it is different from ours. His hours start from the minute he gets into the cage. He gets a check, say number one, and is entitled to come up first, after exactly eight hours. If we were to go to a 48-hours week in our sense we should be working in the mines thirty minutes longer per day than the Ruhr miners, and in a very short time, in my opinion, the Ruhr miner would be back to eight-and-a-half hours or nine hours, and the same old difficulty would be begun all over again.

There should be a half-way course, a course that I have indicated publicly and for which I have been duly publicly criticised; but the fact that it gave birth to criticism is no deterrent to republishing it if that criticism has not destroyed the basis upon which it originally rested. A maximum working week of 45 to 46 hours is the alternative, which should be submitted as the alternative to a reduction in wages. I do not want an increase in the working day or week for its own sake. I do not want a decrease in wages, but having these alternatives before me with no escape, I have come to a conclusion that a

modification of hours as above is the least of two evils. Therefore, sound judgment prompts me to say that, looking at the industry's future, I would keep my hours slightly below those of my most persistent competitor, and I would devote the next five years to the maximum technical development in the hope of getting to the point of productivity where the miners could go back to the shorter working day without financial loss. That I think is just. I know that certain employers have made their wages proposals in relation to a full eight hour day, but I hope that they are regarded only as a basis for negotiation. If I have any influence with employers I would make this one observation to them. Get away from the old idea that you ought only to have a three months' agreement. Take a big risk. We know the difficulties and financial obligations imposed, but take a big risk and bargain as follows:—"For the sake of security in the coal-fields for a five years' agreement, which we ask you to enter into with us, we will proffer wages as they existed before the stoppage. We will arrange your working day in our respective districts, or preferably with you as a national organisation, so as to be no longer than the hours in the Ruhr, or slightly less, and we ask you to join with us on the basis of a five years' agreement to establish the industry once more upon a sound technical financial basis. That is the maximum that the industry can stand. For the first year it could not stand it; but it could stand it if it believed that for the four succeeding years the profits and prosperity of the industry would be sufficient to carry on the development needed."

Having got that five years' agreement, providing that in return for existing wages there shall be a modification of hours, the industry could go to the Government as an industry, not to beg for money, not to ask for money as a gift, but on the basis of this great security to ask the Government to provide the necessary money on loan on agreed terms, so that the industry may be put right on the basis of scientific reconstruction. If it were ten, twenty, forty millions, what does it matter? The nation depends upon our industry. Surely the security is good enough, upon the basis of that agreement, to get from the Government all the money that is necessary to place the industry upon a sound, self-supporting basis.

DISCUSSION.

THE CHAIRMAN (Sir Richard Redmayne) said that it was difficult to introduce a discussion on a matter of this sort when one found oneself so largely in agreement with the lecturer, but there were one or two points on which he slightly differed from Mr. Hodges. With regard to the future of low temperature carbonisation, a matter in which we were all interested, if it was commercially possible it would do a great deal to put the coal-mining industry on its legs. What was required was that processes should be given a chance of being worked on a commercial scale. The Government could do this very simply by putting a tax—he spoke, too, as a hardened free-trader—on imported petrol and removing the tax on the nominal horse-power of motor cars. If they would do this they would

improve the position of low temperature carbonisation and the motor industry of this country, for the design of the British made car would not then be subject to the restriction under which it at present labours. As to the position of the coal industry, it should be considered from two points of view. There was the future and there was the immediate present. He would just like to say how he regarded the immediate present. There was a loss per ton at the end of last March quarter of 1/5 per ton, that on 243 million tons meant 17½ million pounds. The immediate gap that had to be bridged was a trade loss of 17½ million pounds at least. Further, if we took the selling price of coal in 1913 of 10/2 and the selling price at the beginning of the year 1926 of 15/9, the rise was 55 per cent. Coal was far too dear. To say we could right the matter by restricting the output of coal and doing away with a large portion of our export because it was unprofitable and sell our coal at a higher price to our home consumers was economically absurd. Oil and other substitutes for coal only found their chance because coal was too dear. There was only one conceivable solution to the present impasse and that was a reduction of the cost of production per ton. The time worked was the only possible immediate solution he could see short of a reduction of wages. The hours worked at the face in 1905 were seven hours ten minutes; in 1925 they were five hours fifty one minutes. The reduction was equal to a decrease of 18 per cent. of the time worked. The actual production output per person employed at the face showed that the men at the face worked fairly well, in fact better per hour because although there was a decrease in hours of 18 per cent. the decrease in output was only ten per cent., but in persons employed all over the mine the decrease was twenty per cent. The overall personnel employed in the production of a definite quantity of coal was too large. The persons employed at the face had increased by twenty-seven per cent., the total persons employed at the collieries other than coal-getters, that is the non-productive element, had increased sixty-five per cent. The fact of the matter was that the only immediate solution was an extension of working hours. He would go further than Mr. Hodges. To reduce Mr. Hodges' suggestions to a formula it would be to increase the working time by twenty minutes; for that was the difference in working time between our miners and those of the Ruhr. He thought we should want more than twenty minutes in order to bridge that gulf of 17½ million pounds.

But there were other processes of reorganisation and he agreed that they should be carried out by means of a loan and not a subsidy, because a subsidy was a wholly fallacious remedy. We had given the subsidy to collieries that were profitable and to collieries that were not profitable. What would be the effect of the process of subvention? The profitable colliery would be always increasing its output and lowering its price; the non-profitable one would show a decreasing output. A subsidy was a premium on inefficiency. The only immediate solution was an increase of hours and the only one ultimate solution reorganisation and renovation undertaken by capital. He wondered how many collieries were worked on the principle of accumulation of a reserve. Very few! Hence there was no financial source in that direction. It meant, therefore, a loan to many of the amalgamated concerns in order that they might put their house in order and be brought up to the standard and state of the more efficient collieries. There were a number of quite old collieries which could be rendered efficient by a process of amalgamation of organisation and capital expenditure.

Mr. W. Brownhill Smith said there was still another aspect of this question. It had to do with the attempts to improve the means by which when we had got

the coal, we should try to get more efficiency out of it. There were many processes of low temperature carbonisation that would get more out of a ton of coal and allow, if necessary, more to be paid to the producer, and yet not cost the consumer any more in the end. That was a matter where not the Government but municipalities should come in and help. As one of the late members of the gas industry said in 1917, raw coal should not be allowed to be used for the generation of electricity, but coal should be treated in the gas works, the by-products taken from it, and the gas sent to the electricity undertaking. His idea was that gas and electricity undertakings should be side by side. In Glasgow they had been working on this idea on a small plant which was the first of its kind to be built by a municipality. In this plant they were making smokeless fuel giving 45 per cent. more heating efficiency than raw coal in the domestic grate. Out of every ton of coal there were obtained 16 gallons of new oil, not the tarry oil of high temperature carbonisation, but oil which had many more possibilities. That could be done, and the speaker contended that local authorities should be made to come in and do their share by taking up one or the other of the low temperature carbonisation systems. They and the gas undertakings could come in now and help to reorganise the industry in a way whereby men could be paid for the raw material and more got out of it, so that the worker and the user would both benefit.

MR. CEDRIC ERLUND said it had been a great pleasure to listen to Mr. Hodges because of his knowledge and the sincerity with which he had put his views. There was another side which involved, if immediately applied, a remedy for the position; the side that dealt with the wastefulness of the cumbersome methods considered necessary for the movement of coal from the time it got on rail. It was from this cause that all the troubles had arisen that had brought the coal industry to its present position. It was the sole cause. To try to cover up this fact was simply to stand in the way of a solution of the problem. Coal cost too much when it reached the consumer, and it was not a question so much what it cost at the pit mouth, as what it cost when it reached the consumer. There was no justification whatever for the price paid by consumers in this country to-day.

In every department of transport there was one mass of wastefulness and cumbersomeness, and there was no excuse for another day's continuation of the position. To rid the industry of this required that it should be attacked as one would attack a dam that had burst its walls and overflowed valuable land. One would not go to the source of the river; one would apply the remedy where the damage was and the weakness. This problem of the coal industry should be tackled at the point furthest removed from the miner and the colliery first, and the whole business of distribution and retail handling should be consolidated and reorganised, and the speaker believed that a proportion of fifty or fifty-five per cent. could be saved. Take Hove and Brighton; there were 57 coal offices with a vast number of sub-agents, one for every seven hundred families. How in the world could rent, employment of staff and general provision for the people in the business come out of seven hundred families? Worse than this was the transportation. To-day we had a large number of coal waggons not doing all they could do, and many of them only in use about thirty-seven days in a year. If all the waggons were taken over and put into an equipment trust, and used for all collieries, they would never be standing idle, and would be returned empty to the nearest colliery instead of going to the point of origin of their first load. Supposing that coal was wanted from Derbyshire for the Southampton or Brighton area, instead of coming down in mixed trains, which had to be broken up every fifty or sixty miles, and the coal trucks allowed to lie

about until another train could be made up, a solid number of waggons would come down in one complete coal train, and leaving Derbyshire in the evening, would be in Southampton or Brighton the next morning. The train would then be broken up and the trucks distributed to the local depots. Under such a scheme the waggons could be in use 250 days in the year, and by distributing the cost of their employment over a wider basis, would be able to make a much greater return to the collieries on the price of their coal. These were matters of pure business, and quite within the grasp of a central board to direct; and they required no subsidy. On the contrary, they would show such an increased saving that an immediate reduction of price could be made to the consumer of ten shillings per ton of coal, and at the same time money could be handed back to the collieries that in a few months would increase the wages of the miners by probably one pound per week. There was no way in which the general prosperity of the country could go ahead so continuously as by high wages, and no rate of wages that could be paid in this industry could be too high. The speaker believed this plan would have the sound approval of all the mining and other industries. How was money going to be available for technical improvements? By taking over all the colliery waggons into an equipment trust for cash and thus providing immediate funds running into tens of millions and the issue of equipment debentures, which would be one of the finest investments you could have. Through this conversion of the ownership of all colliery waggons into an equipment trust, tens of millions of pounds would be provided for re-organisation of the mines, and all the technical improvements and experiments and exploitation that science could bring to bear.

MRS. DAVID MACDONALD desired to ask whether, when Mr. Hodges quoted hours of work per day, he had an idea how many days a week the men worked? A miner in Yorkshire might only work four days and a miner in the Ruhr might work six.

MR. HODGES said he was glad that Mr. Erlund had made reference to the problems of transportation. References to that were omitted from the paper; he felt that it would mean too much lengthening of his address. The fact that he did not include them did not mean he did not realise the great importance of the matter. As a matter of fact a great number of mistakes could be avoided in transport, and very easily, and he was glad to see that the Government was taking the very wise step of appointing a commission forthwith to recommend steps to be taken to reorganise the transportation of coal in railway pooled waggons. That would probably enable the cost of transport to be considerably reduced. With regard to low temperature carbonisation, referred to by Mr. Brownhill Smith, he was there facing the big problem of the future. It was a crime to waste your vital elements, the chemical elements of coal, in the present prodigal way, and also to waste the economic advantages the producer should be enjoying. It had long since passed the laboratory stage, and only when we could have big plants that would try out all the processes should we be satisfied. There were three important processes known in the world which had long since passed the tests of science, and the Government should erect plants on a big scale to determine whether or not they would stand the test of economic requirements when they were actually in full operation. We must take them from the fifty tons per day stage to the thousand tons per day stage. Then, and then only, could we test whether it was really a profitable proposition.

The figures quoted per shift bore no consideration to the weekly wage. The weekly wage varied by the irregularity of employment, and he had found that work in the

Ruhr until the last six months or so was as irregular as in Great Britain; and in Upper Silesia it had been curtailed to as low as three days per week. There was no restriction of the number of days to be worked in any country.

THE CHAIRMAN had great pleasure in extending to Mr. Hodges their very hearty thanks for his address. He had flown, literally flown, back from Germany to be amongst them that day. He would like to express the thanks of the audience to him for having put himself to great inconvenience to be with them and for having dealt so adequately, fully, helpfully, and opportunely with the subject of his address.

NOTES ON BOOKS.

CAREERS FOR BOYS AND GIRLS. By Sir Herbert Morgan, K.B.E. London: Methuen and Co., Ltd. 6s. net.

This should prove a very helpful book to all parents who are considering the future of their children. It is a survey of the principal careers open to boys and girls, and is a guide to the best means of preparing for the various branches of Engineering, the Law, Medicine, the Services, Education, and last, but not least, Commerce.

Much of the information has, of course, been available hitherto in some form or other, but it has not been readily accessible; even when one knew the best way to go about to secure the desired information a large amount of trouble and correspondence was involved. Here we have clearly set out in handy form particulars of every profession, giving detailed information as to the best means of qualifying for the business or profession in view.

The great value of the book lies in the fact that it is prepared by a successful business man who is able to add much from his own experience to enliven and make eminently readable the particulars and requirements of the entrance examinations for various professional Institutions and for posts in the Government service.

Sir Herbert Morgan justly points out that by the general growth of education the majority of vocations, apart from manual labour, have been elevated to the status of professional pursuits. He insists, therefore, that in preparing for business life, young people should endeavour to pass examinations of the Matriculation standard or to obtain Certificates in commercial subjects such as those awarded by the Royal Society of Arts and other recognised examining bodies.

GENERAL NOTE.

SPECIAL LIBRARIES DIRECTORY.—In view of the enormous amount of scientific and other special information now available in periodicals and libraries, an association—The Association of Special Libraries and Information Bureaux, 38, Bloomsbury Square, W.C.1.—has been formed to assist in making such information available to all who wish to use it. Associate Membership is open to anyone interested. With the assistance of the Carnegie United Kingdom Trust, the Association has undertaken, as one of its first activities, the compilation of a Directory of sources of specialised information in Great Britain and Ireland. The General Editorship of this important work has been entrusted to Mr. G. F. Barwick, late Keeper of Printed Books at the British Museum. Mr. Barwick's scholarshp and long experience will be invaluable for such a task.

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No. 3845 VOL. LXXIV.

FRIDAY, JULY 30th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

PRESENTATION OF THE SOCIETY'S ALBERT MEDAL TO PROFESSOR PAUL SABATIER.

The Council of the Royal Society of Arts attended at Clarence House on July 22nd, when H.R.H. the Duke of Connaught, K.G., President of the Society, presented the Society's Albert Medal for 1926 to Professor Paul Sabatier, Member of the Institute of France, Foreign Member of the Royal Society, Davy Medallist, Nobel Prizeman, " in recognition of his distinguished work in science and of the eminent services to industry rendered by his renowned researches in physics and chemistry, which laid the foundation of important industrial processes."

The members of the Council present were :—Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S. (Chairman), Lord Askwith, K.C.B., K.C., D.C.L., Sir Charles S. Bayley, G.C.I.E., K.C.S.I., Captain Sir Arthur W. Clarke, K.B.E., Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., Mr. P. M. Evans, M.A., LL.D., Sir Edward A. Gait, K.C.S.I., C.I.E., Sir Robert Hadfield, Bt., D.Sc., F.R.S., Sir Philip Magnus, Bt., Sir Richard Redmayne, K.C.B., Mr. A. A. Campbell Swinton, F.R.S., Professor J. M. Thomson, F.R.S., Dr. J. A. Voelcker, Ph.D., Lt.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., and Sir Alfred Yarrow, Bt., F.R.S., with Mr. G. K. Menzies (Secretary of the Society).

EXHIBITION OF INDUSTRIAL DESIGNS.

A selection of the work received in the Society's Competition of Industrial Designs will be exhibited, by kind permission of the Board of Governors, in the Upper East Gallery of the Imperial Institute, South Kensington, from the 31st of July to the 31st of August next, every week-day from 10 a.m. to 5 p.m. The Exhibition will be open free of charge, no tickets being required.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, JUNE 11TH, 1926.

SIR FRANCIS E. YOUNGHUSBAND, K.C.S.I., K.C.I.E., LL.D., D.Sc., in the Chair.

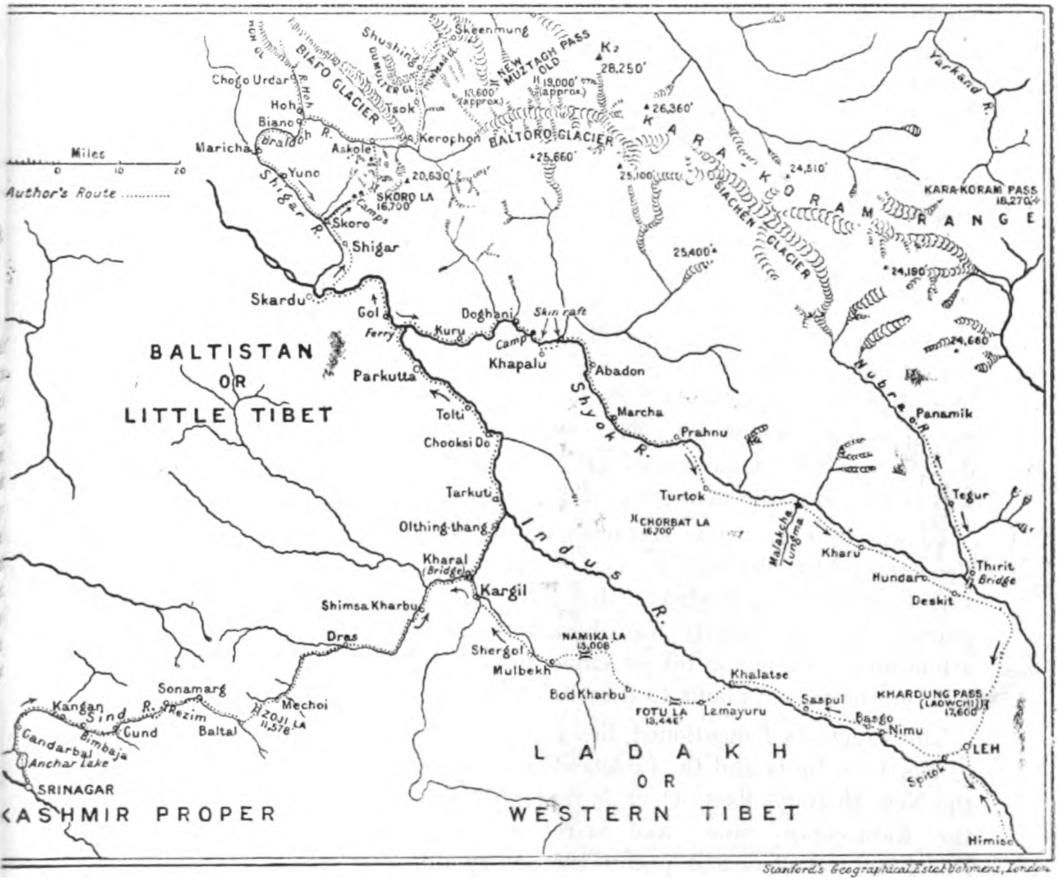
THE CHAIRMAN said it was always a delight to meet a man who had been turned back in exactly the same place as one had oneself. One was always expecting that somebody else would succeed in reaching the place and say what a fool one was to have turned back. In the present instance Captain Featherstone had travelled through one of the most interesting parts of the Himalaya Range, which was explored in detail by Sir Martin Conway, who, he was glad to say, was present that evening. He himself was there in 1887 and went up the glacier, but was sorry to say was not able to get beyond a certain point. Captain Featherstone was stopped in the same place, but fortunately he was able to bring back a very detailed account of what he saw there and also some magnificent views. Captain Featherstone had also travelled in other parts of the world such as Manchuria and Japan, and he was sure the audience would have from him that evening a good account of the wonderful Kara-koram region, and also, he hoped, some travellers who were present would relate their own experiences there.

The following paper was then read:—

TRAVELS IN THE KARA-KORAM HIMALAYAS.

BY CAPT. B. K. FEATHERSTONE.

Before giving an account of my journey, I should like to make it clear that one of my objects in so doing is to draw attention to the Kara-koram Range of the Himalayas, and the possibilities it offers to explorers. This range is situated at the North Western end of the main Himalayan Range and it lies across the direct route between the plains of Northern India and the tablelands of Central Asia. Its physical characteristics may be judged from the fact that it contains within its area, amongst many remarkable peaks and glaciers, the second highest mountain in the world and probably the largest glacier, outside the Polar regions. The mountain is known as K2 or Mount Godwin-Austen, so called after its discoverer, who has but recently passed away. The first known European to cross the range at the point to which I desire to draw particular attention was Sir Francis Younghusband, in the course of his remarkable journey from Pekin to India. Since then this area has attracted expeditions thereto, up to recent times, amongst which may be mentioned those of Sir Martin Conway, the Workmans, the Duke of Abruzzi and others. But so far as I have been able to discover,



(Reproduced from "An Unexplored Pass," by Captain B. K. Featherstone. Published by Hutchinson and Co., Ltd.)

none of them attempted to cross the range or to explore the two passes in that particular neighbourhood, which are shown on the map and known as the New or Western Muztagh Pass and the Old or Eastern Muztagh Pass. It would appear that the earliest reference to any attempt by a European to cross the Western Muztagh Pass was that made by Rudolf Schlagintweit, one of two brothers of that name in the employ of the East India Company. We are told by Godwin-Austen that Schlagintweit made the attempt in 1856, but was driven back by clouds. The next attempt was made by Godwin-Austen himself in 1861 and this failed for the same reason. It should be noted that both these attempts were made from the south side of the pass. But as evidence that the pass in question was then in use, Godwin-Austen mentions having met two natives who had just crossed from the north side. The only further reference to the pass that I have been able to find is that by

Sir Francis Younghusband in his account of the remarkable journey he made from Pekin to India. He reconnoitred the Western Muztagh Pass from the north side and found it impracticable. He then crossed by the Eastern Muztagh Pass and made his way to Askole. Before continuing his journey in the true spirit of exploration, if I may be allowed to say so, he made a reconnaissance of the Western Muztagh Pass from the south approach and found it also impracticable owing to immense glacier changes. Since then I have been unable to discover any reference to any attempt on the New Muztagh Pass or any report as to its state, although there is reason to believe that the natives have used or do use the pass under favourable circumstances.*

I should have said that, in calling attention to the possibilities of the Kara-koram range to the explorer, I had in mind more particularly the area in the immediate neighbourhood of the two Muztagh passes. The route taken by me in making my way to that area is known to travellers and has been described and the same remark applies to my return journey, a part of which was made along the rather less well-known Shyok river valley.

It was in 1922, while stationed in the Khyber Pass with my regiment, the 54th Sikhs (Frontier Force), now known as the 4th Battalion (Sikhs) 12th Frontier Force Regiment, that I first read of Sir Francis Younghusband's journey over the mighty Kara-koram Range, and consequently thought of attempting this minor bit of exploration, which resulted in the thousand mile journey I am about to describe to you.

This range, as I mentioned, lies across the direct route between the plains of Northern India and the tablelands of Central Asia. My plan was to cross the New Muztagh Pass, which is the only known pass not yet explored over the Kara-koram range, and to return by the Old Muztagh Pass; earlier European travellers and native rumour to this day speak of another pass further east, but this has not, up to the present, been definitely located. I left Srinagar, the capital of Kashmir, on June 24th, and returned on September 10th, having travelled over a thousand miles, mostly on foot, at altitudes ranging from 5,000 feet to 18,000 feet above sea-level. This averaged over a hundred miles a week after allowing for a few days for halts.

One of the most important factors in travelling in the Himalayas is the question of transport. Travellers will always have this to contend with, but the difficulties will be greatly diminished if one is fortunate in securing a good *shikari* or headman, who will be found to be a tower of strength. In this connexion I must mention Subhana, my headman, whom I was lucky enough to get. Subhana was about fifty years old, and a native of Kashmir. He

* Those interested in the passes over the Kara-Koram Range will find an admirable summary of the whole of the known information thereon in "Explorations in the Eastern Kara-koram and the Upper Yarkand Valley." Narrative Report to the Survey of India Detachment with the De Filippi Expedition, 1914, "Dehra Dun": Printed at the office of the Trigonometrical Survey of India, 1922.

spoke Persian, Tibetan, Turki, and many hill dialects. He was also widely experienced, having crossed the Kara-koram Range into Central Asia on several occasions. I can truthfully say that but for his ready smile and cheery willingness, and above all his influence over the other natives, I could neither have covered the distance nor surmounted the difficulties encountered on my journey.

Towards evening I set out from the Dal Gate of Srinagar in a *shikara* or canoe. With me were four natives and after a passage of a few hours across the Anchar Lake we reached Gandarbal, where we camped for the night. The following day I began the 220 mile march to Skardu, my first immediate objective. We soon entered the beautiful Sind Valley and in three days arrived at Baltal, a small village lying at the foot of the Zoji La, the lowest point over the Western Himalayan range. We left the following day under a cloudy sky just before dawn. To the summit is about five miles and one climbs 2,000 feet. The rugged path in places becomes a narrow ledge, overhanging a precipice of some hundreds of feet. During the morning the highest point was reached—11,578 feet. Near by lay the skeletons of three men serving as a grim reminder of the perils of Himalayan blizzards. We were soon overtaken by a blinding snowstorm, but after an hour the weather cleared up, the sun revealing a barren and treeless country.

The next day, in the early hours of a frosty morning, we resumed our journey, following downward, first a tributary of the Indus and then the main river. The going was rough at times and the rock-hewn path dwindled away here and there into the face of the cliff. Where there is no foothold, *parris* have been built with great ingenuity. These structures are made by fixing beams of wood into the ledges and crevices of the rocks. Cross-beams are then laid over them, and covered with stones and beaten earth, forming a track. The whole is supported by struts, the lower ends being kept in position by piling rocks round them. Judging by their work the Baltis rank probably among some of the best road builders in the world. After a week's steady going we arrived at Skardu, the capital of Baltistan on July 6th. In the thirteen days since leaving Srinagar we had covered 234 miles.

This part of Asia, in so far as religions are concerned, is probably one of the most interesting in the world. The Baltis are Muhammadans of the Shiah sect, and it is interesting to note that the Muhammadans of the neighbouring countries, Chinese Turkestan, Kashmir and India belong to the Sunni sect. It has been pointed out that we are here at the meeting place of the three great Asiatic religions, and that from this spot and from none other in Asia, can we go eastward to China through countries entirely Buddhist, westward to Constantinople among none but Muhammadans, and southward over lands where the Hindu religion prevails to the extremity of the Indian peninsula.

At Skardu we spent two days repacking our stores and then set out for Askole by a short cut, rarely used by natives. I had great difficulty in finding porters to carry my baggage, as some of the intervening country is uninhabited and the Skora La, 16,700 feet high, had to be crossed. On the third day we were heading up the Skora ravine, picking our way over loose boulders and rocks.

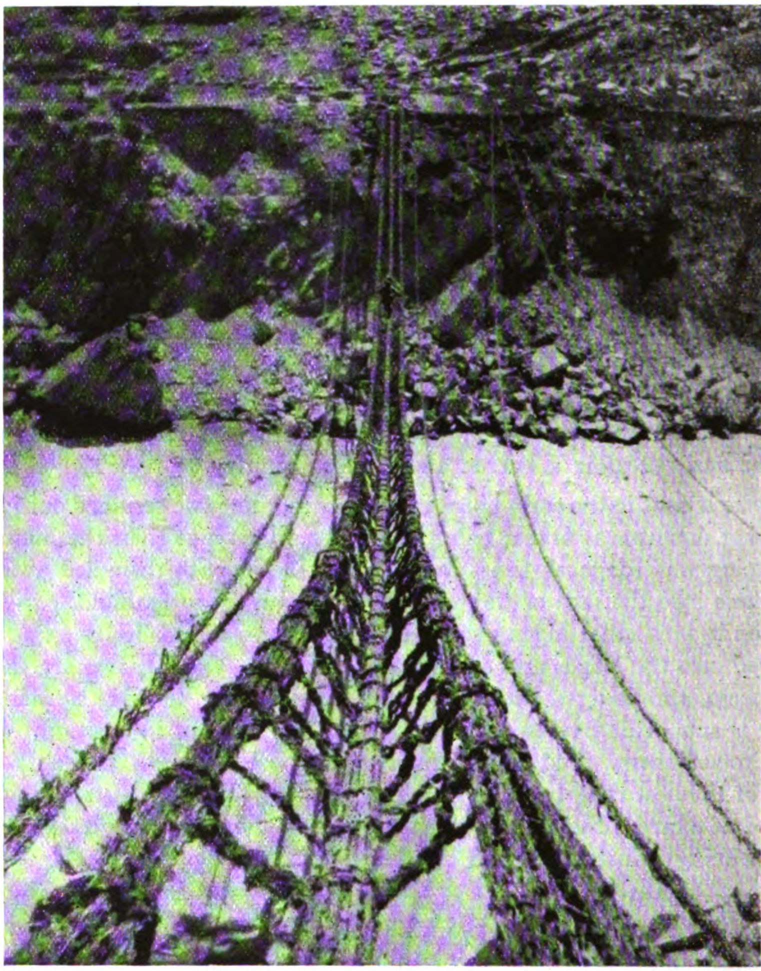


FIG. 1.—Himalayan Twig-bridge across the Braldoh River near Askole.

We forded the torrent six times in the first four miles, and after another nine miles camped at an altitude of 12,500 feet. The next afternoon we halted on a narrow ledge about 15,000 feet high. There was no room to pitch a tent, so I spread out my bedding on the ground. Having remembered to collect some fuel, we had some hot native tea made from melted snow, and

turned in early. Though there was every prospect of good weather and a peaceful night, I woke later to find a bitterly cold wind and driving snow. At the first glimmer of dawn I roused the seemingly lifeless porters and we were soon climbing up a steep slope of frozen snow, the carriers with their loads finding great difficulty. A sudden rumbling sound reminded us of the danger of avalanches and had we been a few yards further on we might have been swept down thousands of feet. Small avalanches continued throughout the ascent, but we made the summit at noon. Before us stretched a vast snowfield, pierced by enormous jagged rocks, while beyond lay a glacier glistening in the midday sun. The porters dropped their loads and forming a circle, offered up a fervent prayer of thanksgiving to Allah for having brought them safely through "hell's road," as they termed it. Loading up again we struggled over the snowfield, often sunk above our knees, and half blinded by the dazzling whiteness. We at length found a suitable camping ground at the end of the glacier, not far from a deserted village, which the inhabitants had left owing to the glacier advancing. At three o'clock the next afternoon, we arrived on the left bank of the Braldoh River. Here my carriers at first declined to cross the *jhula* or twig-bridge. These Himalayan twig-bridges are made solely from the small branches and twigs of trees twisted together to form ropes. The span of this bridge is 270 feet, the rope ends being about 80 feet above the water-level and sinking to 40 feet in the middle. To those interested in the name of the tree of the branches of which the bridge is made; I may mention that the Director of the Botanical Gardens, Kew, states that it might be *Parrotia Jacquemontania*. Captain Kingdon Ward, the botanist and traveller, tells me that this shrub resembles the hazel, though not botanically related.

After over an hour's delay I eventually succeeded in persuading my porters to cross. In justice to them I should mention that none of them had ever crossed one, for they are not used in their part of the country. With a strong wind blowing these bridges are very apt to sway horizontally and also move vertically, and they are decidedly a kind of bridge one would not want to cross every day. I think I am right in saying that the late Lord Curzon, in a travel book, described the crossing of one of these bridges as one of the most thrilling experiences of his life. I was recently asked how these bridges were kept in repair, as while I was crossing it, this was a cause of some anxiety to me. I was reminded of the stories concerning the cliff monasteries in Thessaly. Some of these can only be visited by being hauled up in a basket tied on to the end of a rope and the rope is never changed until it breaks. I can only say that at one part of the bridge there appeared to be only a few twisted strands left.

My welcome in Askole was not at all enthusiastic, and most travellers report a similar state of affairs on arrival there. The rumour quickly spread that I was trying to cross the Western or New Muztagh Pass. Askole is

the name given to a group of seven villages lying 10,000 feet above sea-level. Wrapped in winter for eight months of the year it is a kind of world's end on the edge of a sea of ice formed by some of the largest glaciers outside the Polar regions. I had great difficulty in getting porters. The idea of going somewhere with no ostensible object does not appeal to them. They are superstitious about mountains and fully conscious of the dangers. It is, therefore, not surprising that the Baltis are unwilling to travel in uninhabited parts, for Askole is the last inhabited place—beyond it lies the icy wilderness of the Kara-koram Himalayas.

I shall not readily forget my departure from Askole on July 16th. The women tried to persuade the men not to accompany me, and only after hours of incessant arguing were we clear of the village. We soon sighted the Biafo glacier, a mass of ice some three hundred feet thick and over thirty-five miles long and nearly a mile wide. Never before having seen a Himalayan glacier of any great size, I must own to feeling excited at approaching this glacier, one of the largest in the world. I had previously caught a glimpse of it on my way down from the Skoro La to Askole, and instead of the usual blue-green or dark ice-colour glacier, as seen from a distance, no ice of any kind was visible. We finally reached the Biafo by going up a small valley and climbing a steep bank covered with loose stones and rocks. At this point we could not see the actual snout, which was away to the right, but we heard a constant roar of water escaping from under the ice, which extended over the valley and was some hundreds of feet deep. The surface, covered with detritus, was broken up into a tortuous collection of ridges, depressions, caves, and small running streams with the ice in places exposed.

My real transport difficulties now began. The porters, eighteen in all, arrived about half-past one and I tried without success to make them go further. In order not to waste time I decided to reconnoitre the Biafo glacier, in particular its snout. The question of the movement of these enormous masses of ice is one of great interest, but time will not now permit me to go into that question. I will just show you one or two pictures of this glacier.

The next day sleet fell and the porters threatened to return. Eventually we proceeded and late that night arrived at Tsok, where the men actually mutinied, throwing down their loads and starting to desert. With Subhana and others I intercepted them and drove them back. After I had promised them one of two sheep I had with me, and a day's rest, they agreed to stay; but when the journey was resumed, and a short march had brought us to the Punmah glacier, which leads to the New Muztagh Pass, discontent was again rife. It was only after a long discussion that they were persuaded to continue up to the Dumulter glacier.

On the following day the men once more refused to advance, saying their food had run out. This was untrue, but I persuaded four porters to accompany me up the Punmah glacier as far as Shushing, situated just this side of

Chongulter. All attempts to make them go further were useless, but two days later, with one porter I left for Skeenmung, which is only some few miles from the summit of the Western Muztagh Pass. The surface of the glacier was very uneven and it was very hard going. I reached a point just opposite Skeenmung—a point from which I judged it might with luck be possible to make the ascent up the pass and get back the same day. Finally, there was nothing to be done but to abandon the attempt of reaching the summit, so with one last look in the direction of the pass, I turned back towards camp, disheartened and beaten on the post, so to speak. There was nothing else to be done, though it was not easy to give in after travelling some 350 miles for the purpose of crossing the pass, and getting within a few miles of the summit.

I had one consolation left me, however, when I reflected that I had trodden classic ground, and as the names of those who had made attempts on the pass occurred to me—names to conjure with in the history of Himalayan exploration—I felt that I could say, in all humility, that I had failed in good company. I have said that the most I dared hope for was to be able, with great luck, to find a way up the New Muztagh Pass and down by the Old Muztagh Pass. As an officer on ordinary leave with modest financial resources, I should have counted myself among the very fortunate ones had I succeeded to that extent.

But I will own that, in the back of my mind, was the possibility of seeing something of the country on the north side of the pass. That territory is still awaiting complete exploration, though a start has been made on it, and some of you, doubtless, heard Sir Francis Younghusband recently give elsewhere a most interesting account of the "*Problem of the Shaksgam Valley*," to use the name by which the territory in question is now known.

To resume our journey; the following day we made a short march back to the Dumulter glacier where my main camp was established, and two days later I reached Askole again. Returning to Skardu I took the Braldoh River route, which is generally used in preference to the short cut over the Skoro La. Near to where the Hoh river flows into the Braldoh we had to cross a *shwa* or mud stream. This stream was flowing or moving in a channel three yards wide with perpendicular banks of soft soil about 10-15 feet high and was very difficult of approach as the soil gave way under any pressure. The stream itself consisted of semi-liquid mud, interspersed with boulders and rocks. It was uncanny to watch the resistless way in which the moving mud laid hold of—so to say—these large rocks, moving them in a much firmer manner than water would have done. At times the surface of the stream was reduced, due to the mud and rocks temporarily blocked above accumulating—only, however, to burst forth later in an overwhelming manner. It took some time to cross the *shwa*, but happily the passage was accomplished without mishaps. Subsequently I followed up the Hoh River, camping at Chogo Urdar on the edge of the Hoh glacier. Owing to rain and a heavy mist, little

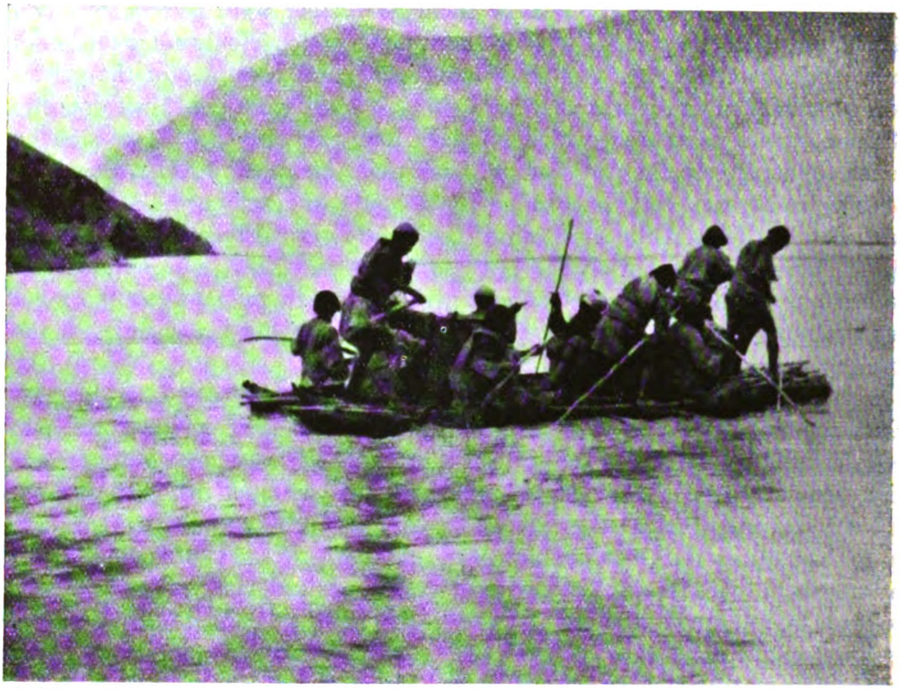


FIG. 2.—Skin-raft crossing Shyok River. (Reproduced from "An Unexplored Pass," by Captain B. K. Featherstone. Published by Hutchinson and Co., Ltd.)

could be seen of either the glacier or the surrounding country, so I returned to the Braldoh and continued my journey along the banks of the river. At Shigar a *zak* or skin-raft was placed at my disposal and I was able to avoid walking the last sixteen miles to Skardu, a respite all the more welcome because the way was mostly over loose sand. The *zak* consisted of about sixteen goatskins inflated and fastened to a wooden framework, six feet square, made of thick branches lashed together; the *zakwallas* or crew number four and steer with poles. I climbed on to the raft which drifted into midstream. There were dangerous rapids ahead and our speed increased steadily. We were soon projected violently into what appeared to be a wall of water, half submerging the raft and causing it to creak in a most alarming manner. Once through the rapids we floated along quietly and set to work to re-inflate the goat skins, this being done by blowing through one of the legs. Later we were held up on a sandbank for an hour and had a skin torn off by a rock, but we reached Skardu without further mishap.

At Skardu we replenished our stores and on August 7th started off for Panamik on the Yarkand Road, a place just south of the Kara-koram Pass. At the confluence of the Indus and Shyok rivers, where there is a ferry, we crossed in a barge and continued along the right bank of the Shyok for

two days, arriving at Khapulu. Following upon a day's rest we set off early in the morning, but, unexpectedly, it took us till evening to get over the Shyok again by skin-raft. As soon as we were all across we started along the river bank, and when it became too dark rested in the open until the moon rose, finally reaching our destination at sunrise. Not wishing to lose time, after a belated breakfast, we took fresh porters and made for Prahnu, sixteen miles away. It was not till after dark that Prahnu was reached, after a march of thirty-six miles without resting. We found the inhabitants hostile and they refused us a camping ground, so finding a suitable place ourselves, we occupied it. While the tents were being unloaded a squabble began and things looked serious. Order was soon restored, the rest of the night, on the whole, being peaceful, except for a few rocks and stones hurled at us.

This question brings me to rather an interesting point, which at first sight may appear to be political in nature, but such is not really the case; the Royal Society of Arts have naturally asked me not to enter on a political discussion. What I may perhaps be allowed to mention is the general undercurrent of anti-British sentiment I found at the time in these parts. Of all the districts passed through, this manifestation was strongest in the hundred and fifty miles of the Shyok Valley. The following explanation was given me, on the spot, by those in a position to judge of the facts. I give it for what it is worth. It is said to be due to natives, who having visited Simla, Kashmir and other places in search of work, return full of anti-British propaganda, picked up from agitators. I learn, however, that in this respect things are now, happily, much improved.

Resuming our journey—the next day we had some difficulty in getting out of Prahnu, but managed by means of bribery to get a sufficient number of porters to take our baggage to Turtok, the last village in Baltistan. I happened to mention to the head-villager my trouble at the previous village. He expressed great concern at our treatment and proposed that he should join me with some of his men to make a raid on the offending village by way of reprisal. He added that we could carry off some of their women and priests as hostages. I am afraid I fell in his estimation when I declined his proposal.

The next morning we started on a march of thirty-six miles to Kharu, across the borderland between Ladakh or Western Tibet. During the day we met a native band which played in my honour, and their music, I understand, has features of interest to students owing to the intervals employed which are said to appeal to some of the ultra-modern composers, though easily beyond my musical knowledge. Towards sunset on the second day we came to Kharu and it was curious to note that the stretch of country which we had traversed since leaving Turtok was a kind of no man's land, absolutely barren—with no important physical features of any description; yet the inhabitants of the two provinces are entirely distinct in race, religion and customs. We had left behind Muhammadanism and entered the land of Lamaism.

FIG. 3.—Balti Musicians. (Reproduced from "An Unexplored Pass," by Captain B. K. Featherstone. Published by Hutchinson and Co., Ltd.)

FIG. 4.—Group of Ladakh Women. (Reproduced from "An Unexplored Pass," by Captain B. K. Featherstone. Published by Hutchinson and Co., Ltd.)

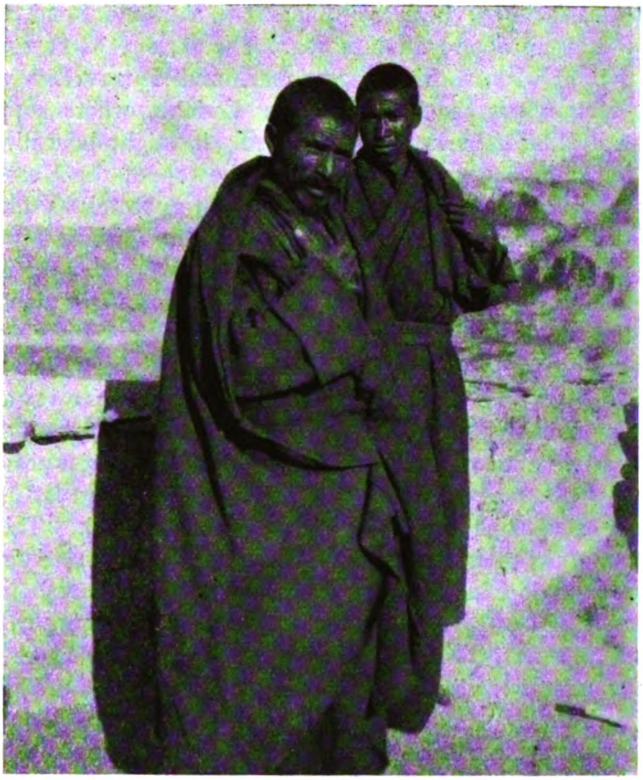


FIG. 5.—Lamas on Monastery Wall.

Kharu owes what little importance it has to its being the first place over the border between Baltistan and Ladakh. The houses, generally of one storey, were irregularly spaced, with here and there a tree. From some of the houses were flying prayer flags of coloured cotton, and women with their peculiar head-dress called *pirak*, gathered on the flat roofs, some to pray, others to watch our arrival. We left the next day for Deskit. Just outside Deskit, two lamas or priests welcomed us and kindly offered me a place for my camp in the monastery compound. A glance at the suggested place showed it to be very dirty, but not wishing to hurt the lamas' feelings, I pitched my tent there. As soon as it became dark, three large dogs, rather like Alsatian wolfhounds, were let loose to ensure our safety. I thought of the stories of the monks of St. Bernard and the dogs kept to rescue travellers in danger on the Alps. In our case these animals did their work so well that none of us dared move, as to do so was the signal for prolonged barking and blood-curdling growls.

Leaving Deskit the next day we waded through stretches of flooded land, and after crossing the Shyok River by a fine suspension bridge, built by the

Government to facilitate trade, we joined the Yarkand Road, where I soon overtook a caravan bound for Kashgar. The owner, a Turcoman, was a handsome fellow with a friendly manner, and I travelled with him to Panamik. Panamik is the last village in Ladakh, where supplies can be obtained until Chinese-Turkestan is reached; it might be called the "rail-head" of the trade route. From there to the top of the Kara-koram Pass is a six days' journey northward, and my idea was to take a few ponies for the trip, leaving the bulk of my baggage behind. Owing, however, to the limited time at my disposal, not to mention the exorbitant prices demanded, I had to abandon this plan and decided to return to Sringar via Leh.

We started off, and after two days recrossing the Shyok River by the suspension bridge, we reached Khardung, one of the highest villages in Ladakh. The next day we set off for Leh, which was twenty-five miles away and there was a pass, 17,600 feet high, to be crossed. We ascended gradually for the first eight miles and then came to a steep part leading over a glacier near the summit. Ahead of us was a caravan and I saw two ponies slip and fall, sliding down the ice until brought to a standstill by a projecting rock. This death-trap at the bottom of the ravine was filled with carcases of animals; above hovered a number of grim-looking birds of prey, probably kites, fresh from feasting on the remains. It was not long before we were all suffering from mountain sickness, my servants being utterly overcome. We reached the summit and below us saw the Indus River winding its way along the valley, and in the distance the highest peaks of the Kara-korams showed up clearly. The descent seemed long and tedious, and only at nine o'clock that night did we arrive at Leh.

Leh has so often been described that I will only refer to it briefly. The question of its origin is of some interest, though one can find no mention of it in early times. Inasmuch as the first known inhabitants were a nomadic tribe of Tibetans it is fair to assume the possibility of Leh existing from earliest times as a trading centre. Its natural topographical position at the inter-section of the trade routes to Yarkand, Lhasa, Kashmir, and India, tends to this supposition. Nowadays along these roads in both directions are carried imports and exports in considerable quantities, either for through transit, sale, exchange or barter in Leh. The situation in Russia has, of course, affected the conditions of trade. Trade, however, is on the increase and statistics for the last ten years show a great relative increase in value, a feature now common to most trade reports, but the actual weight of goods over this period has not varied much.

I may mention that while in Leh I had a good offer from a reliable and trustworthy trader to take me in disguise to Lhasa and see me safely back. But this tempting offer had, to my regret, to be declined for various reasons, not the least of which that I had signed an undertaking not to cross the Tibetan frontier.

During the few days I spent in Leh I visited Hemis, the well-known largest monastery in Ladakh, and then continued my journey to Srinagar, 241 miles distant. It was a long and dreary march, including the crossing of the Fotu La and Namika La, each pass some 13,000 feet above sea level. September 5th saw us in Mechoi and the next morning we started up the gradual ascent leading to the Zoji La. The snow had vanished and the pass had a very different appearance from that which it had presented three months earlier. Beyond it we again passed through the Sind Valley, which already had an autumn tint. Here all the savage grandeur and the fantastic appearance of the Karakorams were left behind and the eye dwelt with enjoyment on the change. Bare rocks had given way to verdure and the mild air with its smell of vegetation was welcome. We reached Srinagar on September 10th, after having covered 1,100 miles in just over eleven weeks at altitudes varying from 5,000 feet to 18,000 feet above sea level. Travelling at the rate of about 100 miles a week, I had not had much time for scientific observations, but I was able to record the present conditions and movements of some of the glaciers.†

It was a great regret to me that the Askolean porters failed me at the Muztagh Pass, and I felt inclined at the moment to have gone on alone, but Subhana tactfully pointed out the foolhardiness of such a course. Though defeated, like others, by the forces of nature—human and otherwise—I hope some day, with the experience gained, to make another attempt to cross the unexplored New Muztagh Pass. In the meantime, I shall be very glad if this account prompts anyone, possibly tired of, say, winter sports in Switzerland, to undertake and successfully carry out this minor bit of exploration.

† An account by Captain Featherstone of the movements of the Biafo glacier will be found in the Geographical Journal, Vol. LXVII, No. 4. April, 1926.

DISCUSSION.

The Chairman said he was very glad to hear from the last part of the address that Captain Featherstone still hoped to be able to go back some day and attain the object with which he started on the last occasion, that was to say, cross the New or Western Muztagh Pass. That would be an extremely interesting and valuable piece of exploration, because no European had been known to cross the New Muztagh Pass. He himself had the good fortune to cross the old one in 1887, and the German mountaineer, Mr. Ferber, ascended it from the Indian side. He did not think anybody else had crossed the Pass, and it would be a valuable piece of exploration to go up through the Western Pass and come down on the Northern side, the side on which he travelled in 1887, and come back over the Old Muztagh Pass. That was a perfectly feasible piece of exploration which anyone with Alpine training and experience might hope to carry out successfully. Neither Captain Featherstone nor he himself had that Alpine training and experience or equipment, and consequently they were hung up by obstacles which would be nothing at all to any member of the Alpine Club. It was a project which might appeal to some of the enterprising officers serving in India, as it had already appealed to Captain Featherstone. In the meanwhile, perhaps he would be able to obtain some Alpine

experience; such experience was very valuable, and with it he was certain he would be able to carry out his plan.

Another piece of advice he would give was to take up specially enlisted porters, as was done in the Mount Everest Expedition. If an explorer went to the furthest village and took up stray men it was impossible to do the work; it was hardly fair to them for one thing, and, for another thing, they would not do it. If half-a-dozen good porters were taken up and paid well for the trip, he thought it would be perfectly feasible to get over the New Muztagh Pass and back through the old Pass. As a matter of fact, he had been fortunate in having men from the village of Askole who had gone over to Yarkand 25 years before he was there; they knew the route and undertook to go along with him. When they arrived at Askole from the North they were in great fear of the inhabitants, because the inhabitants did not like the route across the mountains being shown to anybody as they were afraid of raiders from Hunza attacking them and therefore they discouraged travellers in every way possible. The guide who took him over, although a native of Askole, was afraid to remain there and went on with him to Kashmir. Captain Featherstone had referred to his modest financial resources, but they could not have been more modest than his own, which were none at all. When he arrived at Askole he had no money to pay the people, but very fortunately a sympathetic native telegraph clerk at Skardu sent a telegram to the Governor of Kashmir who telegraphed him a few hundred rupees, but literally he arrived at Askole without a single rupee and no food and only native boots.

The author had shown some pictures of rope bridges, and mentioned Lord Curzon's description of his crossing one of them. He had the pleasure of being with Lord Curzon at the time he came to visit him in Chitral and on his way encountered a rope bridge. Such bridges had no terrors to one who was accustomed to them, but he had forgotten to tell Lord Curzon about the bridge they had to cross. When Lord Curzon saw the bridge, he looked a little uncomfortable, but went across very pluckily indeed.

With regard to the inhabitants of the region, the Baltis—if they were taken in the right way, as Captain Featherstone obviously took them—were an agreeable people, very hardy and plucky. Sir Martin Conway could confirm that, as he took them to some very nasty places on the glacier, but the man who had most thoroughly exploited their capacity for usefulness was the Duke of Abruzzi, who engaged about 300, and found that a certain percentage were very good in rough places. The Duke of Abruzzi was a trained mountaineer and had with him Italian porters from the Alps, and he said that if the Baltis were taken in hand and treated well it was possible to find amongst them quite a useful lot of porters, whom, in fact, he took up to about 20,000 feet. He thought it would be possible gradually to obtain among those people a certain number who would be able to go up into the glaciers and over the New Muztagh Pass and down by the old. This, as he had said, would be a most interesting piece of exploration. The explorers would see some of the finest scenery in the Himalayas and add to the stock of geographical knowledge.

Sir Martin Conway had been a pioneer in Alpine climbing and had the enterprise to go out to the Himalayas years ago with a party, and he would ask him to speak in the discussion.

SIR MARTIN CONWAY, M.P., LITT.D., said he had employed in the year 1892 a good many Askole coolies—he believed most of the population of the village. He was accompanied by three of four Gurkhas, who were put at his disposal by the Government of India, and they exercised a kind of moral persuasion which enabled the people

to go to places which they sometimes did not wish to go to. He was fortunate in that respect, because otherwise it would have been quite impossible to have travelled any further up the glacier valleys than Captain Featherstone was able to do. He had felt compunction in taking the men on to snow and ice because they had not proper footwear. He only took them once into bad places, but would never do it again, as it was not fair to them. The proper thing to do was to take out plenty of boots and get the coolies accustomed to using boots. The soft untanned leather shoes they wore were hopeless on snow and ice.

The Punmah glacier which led to the New Muztagh Pass was one which was said by everybody to be difficult. He had wanted to get over and could have easily got over to it from the wonderful snow lake at the head of the Biafo glacier ; there was a low pass which was perfectly easy, leading to the basin of the Punmah glacier, and he had planned to cross over to the Punmah glacier in that way and then over the New Muztagh Pass. But the snow was in such a soft condition, and the distance so great, and the coolies suffered so much from the cold at night, that the plan had to be given up and the party came down the Biafo glacier. Sir Francis Younghusband had crossed the Old Muztagh Pass, but he himself had never crossed it, or properly seen it. According to the information given by the German explorer, who ascended from the south, it appeared not to be an easy matter at all, and how he, Sir Francis, and the men he had with him were able to get over it without any proper mountaineering appliances was one of the great mysteries of travel. Any explorer who wished to go over one Muztagh Pass and back by the other should certainly go up the Old and come down the New, because it would be safer to cut steps up the Old Muztagh than to cut them down. He was reminded by the books he had written from time to time that there were blind spots in his recollection of the Kara-koram district. Everything was vivid for a certain distance, and then came a blind spot, and it was very curious that certain portions of their journey had absolutely vanished out of his memory. This was the case with the Skoro La. He did not remember how his Expedition got up or how they came down. One thing he did remember was that the abandoned village spoken of was inhabited in those days and the people turned out and gave a great dancing exhibition for him. Another light spot in his memory was his recollection of their travelling down the Indus on a skin raft, such as that which was employed by the Assyrians on the Euphrates in ancient days.

He had been very pleased to hear Captain Featherstone's delightful account of his journey and admired the excellent and well-selected points of view given in the photographs. The mountains in the district were splendid, the finest mountains in the world, and he felt sure that Captain Featherstone would, before very long, find himself compelled to go there again, and, if he did, he did not think he would be content with going over one Muztagh Pass and coming back over the other—he would look at one of the most interesting unexplored places in the world, the whole of the country north of the great watershed of the Kara-koram Range.

Air Vice-Marshal Sir Sefton Brancker, K.C.B., said that Captain Featherstone's address had recalled to him some of the happiest days in his life, for he once had a four months' shooting trip in that part of the world. He believed the Subhana who was mentioned was the same man who, as a young man, was on the shooting trip with him 23 years ago. He did not go to the Muztagh Pass but went to the Nubra Valley and over the Sasseer La, and, like Captain Featherstone, was forced to turn back, as his porters would not go on. It was a fascinating country, and he had always meant to go back but had never succeeded. If a man took his boots and hat off in the middle of the day, and kept his feet in the shade and his

head in the sun, it would be a question of whether he would sooner get frost-bite in his feet or sunstroke in his head.

With regard to the old Buddha cry, "Om mani padmi hong," referred to by Capt. Featherstone, he had asked a good many people what it meant, and he had come to the conclusion that the best literal translation was "Oh, the nothingness of life!"

He hoped Captain Featherstone would be able to get back some day to the enchanting country he had described.

Brigadier-General Sir Percy Sykes, K.C.I.E., C.B., C.M.G., said he had been recently going through the papers of his old chief, Sir Mortimer Durand, who referred to the northern frontier of India as the strongest in the world, and he thought the explorations of Captain Featherstone had proved him to be right. Sir Mortimer also referred to the valuable explorations done by Sir William Lokhart and Sir Francis Younghusband, and mentioned that by the accurate information they supplied, the Government of India were able to take steps for countering the very aggressive movements of the Russians in the '80's. The valuable explorations of Sir Francis Younghusband as recorded in his book were the cause of Captain Featherstone undertaking his expedition. It was Sir Francis who lit the torch which was now being carried on by others.

Mr. F. O. Lechmere-Oertel thought he could give a translation of the phrase "Om mani padmi hong," which was in Sanskrit the sacred language of the Northern Buddhists. *Om* was hail, *mani* jewel, and *padmi*, a lotus, and the whole meant "Hail to the jewel of the lotus, hail!" It was here evidently a salutation to Buddha, as the jewel of the universe. The formula was common all over India, where it had a mystic meaning attaching to it. He had seen the inscribed stones referred to by the lecturer at Maulbek and elsewhere on the Ladakh route.

On the proposition of the Chairman a hearty vote of thanks was accorded to Captain Featherstone for his interesting lecture also beautiful slides, and a vote of thanks to the Chairman concluded the meeting.

NOTES ON BOOKS.

The Mystery of Mind. By L. T. Troland. London: Chapman and Hall. 15s. net.

This volume, written and printed in the United States of America, is one of the "Library of Modern Science," now under issue by Messrs. Chapman and Hall; the author being introduced to us as Assistant Professor of Psychology in Harvard University, and the preface makes it clear that the author regards his work as a handbook of psychology in a usual or standard sense. He, however, does not appear to us to treat the subject quite in the present day sense, as meaning a practical study of mentality, disposition or behaviour in its bearing on the duties or occupations of daily life, industry, and social economics; an aspect of psychology which has become of considerable importance in Great Britain, as evidenced by the fact that we have an association for promoting the study of psychology in its practical bearing on industry and efficiency, and many valuable works in which this is the leading idea.

At the beginning of Chapter VII (p. 97) the author says:—" American psychologists have recently been much excited by a movement in their science known as *behaviourism*," and he himself evidently dislikes the movement as he says:- " Behavourists vary in the degree of violence with which they attack the more conventional forms of psychology. John Watson, the leader of the movement, says he does not know what consciousness is."

The John Watson, whose views the author deplores, regards a real or fundamental knowledge as to the nature of consciousness as beyond the mundane range of our intellect: and many, perhaps most, British psychologists are likely to assent. Mr. Troland, however, appears to think that establishing some kind of inter-relation between consciousness and the nervous organisation with a consideration of matter itself, in its atomic and other aspects, affords demonstration as to the nature of consciousness or casts light on the mystery of mind. Thus it is that he has but scant space for psychology as the term is now generally applied, i.e., psychology as an exponent of the main-springs of behaviour and as a practical guide to effective or useful systems and modes of effort.

Professor R. S. Woodworth, of Columbia University, has recently given us a volume on " Psychology; a Study of Mental Life," in which the practical side predominates and this volume has been re-issued on our side of the Atlantic by Messrs. Methuen. Dr. Woodworth, on p. 2 of his volume, tells us how "waggish critics" have summarised the gradual change in the accepted meaning of the word psychology. "First, psychology lost its soul, then it lost its mind, then it lost consciousness; it still has behaviour, of a kind."

CORRESPONDENCE.

HORSE TRANSPORT AND MOTOR TRANSPORT.

A friend much interested in transport problems has written to me as follows:—

> " It seems extremely strange to me that neither Mr. Paterson nor any of the many gentlemen who took part in the discussion, mentioned detachable roller box bodies. These would, I think, solve all the difficulties, both of horse-vans and lorries; enabling them to serve large numbers of customers simultaneously with one transporting vehicle and at a minimum cost; for, as Mr. Paterson says, half the total time of the expensive power units (the horse or engine, and the underframe and wheels) would be saved by not being required to wait while the retail consignments were being loaded, unloaded or unpacked. Detachable loads are mentioned, but in the sense of separate vehicles or trailers, not of lorries and vans and trailers with roller box bodies on them. The latter are of small and varying sizes to suit regular customers who are thereby saved packing expenses."

Mr. H. W. Perry has permitted me to hand on these remarks to you, as they appeared to be rather interesting.

C. T. Jacob.

Tuticorin,
India,
5th July, 1926.

No. 3846. AUGUST 6, 1926. Vol. LXXIV.

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FRIDAY, AUGUST 6th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

THE QUEEN AT THE SOCIETY'S EXHIBITION OF DESIGNS.

The Queen, accompanied by Lady Cynthia Colville, paid a private visit on Tuesday, July 27th, to the Exhibition of Industrial Designs of the Royal Society of Arts in the Upper East Gallery of the Imperial Institute. Her Majesty was received by Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council of the Society, Lord Askwith, K.C.B., K.C., D.C.L., past Chairman, Lieut.-General Sir William Furse, K.C.B., D.S.O., Director of the Imperial Institute, Sir Frank Warner, K.B.E., Chairman, Central and Textile Committees, Mr. E. R. Edis, Chairman, Pottery and Glass Committee, Mr. J. A. Milne, C.B.E., Chairman, Book Production Committee, Mr. Octavius Satchell, Chairman, Furniture Committee, and Mr. G. K. Menzies, Secretary of the Society.

Her Majesty inspected all the work shown, expressed much interest in the Exhibition, and was graciously pleased to purchase two of the designs.

The Exhibition will be open free of charge, no tickets being required, until the 31st of August, every week-day from 10 a.m. to 5 p.m. It includes Designs in Architectural Metalwork (Shop Fronts, Lift Enclosures, and Window Frames), Wallpapers, Textiles, Furniture, Printing and Book Production, China, Earthenware and Glass, as well as Designs for Posters, Showcards, Exhibition Stands, Chocolate Boxes, Lay-outs, Price Lists, and Endpapers submitted for valuable Prizes offered by a number of well-known firms.

REPRINT OF CANTOR LECTURES.

The Cantor Lectures on "Coal Ash and Clean Coal," by R. Lessing, Ph.D., M.I.Chem.E., have been reprinted from the *Journal*, and the pamphlet (price 2s.) can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A full list of lectures which have been published separately and are still on sale can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE DECORATION OF FURNITURE.

By H. P. Shapland, A.R.I.B.A.,
Editor of the *Cabinetmaker*.

Lecture I.—*Delivered January 18th*, 1926.

Though decoration is not essential to good furniture, its universal use suggests that ornament of one kind or another is a genuine need of the human mind. The furniture maker is primarily concerned with construction, just as the builder is primarily concerned with construction, but even in the simplest types the desire of the craftsman to add some touch of fancy or distinction to his work is evident, and it is extremely difficult to find furniture of any sort whatever in which the decorative element is entirely absent. During the war I had sent to me by a cabinet-maker in the trenches a pencil drawing of some rough furniture which he and his comrades had made out of ammunition boxes and boughs of ash which they had cut in the neighbourhood of their billets. They were not content to make this furniture, but added a touch of decoration by removing rings of bark at intervals in order to vary the colour. The instinct for decoration was so strong that it prompted them to do that kind of thing, even in the appalling circumstances in which they found themselves.

The Society of Arts has asked me in these lectures to review briefly the various forms of decoration used by cabinet-makers to embellish their work, and to that task I will now address myself, not without due appreciation of its difficulties. The field to be covered is so vast that all I can hope to do is to give the main outlines of the subject without going very much into detail. I will first enumerate the main heads under which the decoration of furniture falls: moulding, piercing, turning, twisting and carving. All these forms of decoration deal with manipulations of the wood, but having disposed of them we are only at the beginning of the long list of methods which the cabinet maker may use for embellishing his work. A mere catalogue of these is formidable enough. It includes veneering, marqueterie, parqueterie, boulle work, graining, lacquering, painting, enamelling, polishing, gesso work, staining, gilding, the overlaying of the surface of the wood with ivory, tortoiseshell or precious metals and the covering of the entire surface with textiles or leather. Then again there are pieces which rely almost entirely for their decorative effect on the use of applied metal work, decorative hinges, lock plates, escutcheons and handles.

MOULDING.

First of all then, moulding, which differs from other methods of decoration in so far as it plays, in many instances, a utilitarian as well as a decorative part in furniture manufacture. Moulded detail renders furniture pleasing to handle, and cabinet work from which it is entirely absent is rare. Take as an instance the hand-rail made of a square or rectangular section with edges left quite sharp from the plane. Such a hand-rail would cause great discomfort and possible injury. This applies also to the tops of tables, the posts of bedsteads, and the arms and seats of chairs. In all these instances, the harsh exterior angles may be softened and rendered pleasing to the touch by moulding. But here I am more concerned to draw attention to the decorative qualities of moulding. In early work mouldings were formed on the solid wood, and the making of mitres entailed a great deal of labour. This led to the moulding of stiles and rails on the surface rather than at the edges, as the need for mitres at the angles did not then arise. Later, when mouldings were made separately, and subsequently applied to the work, mitreing was facilitated and decorative possibilities were much increased. The transition from the square panel to the octagon was rapid, and at the beginning of the 17th century drawer fronts and doors were covered with intricate geometric patterns—squares, pentagons, hexagons, octagons and circles, or segments of circles, combined in all manner of ingenious patterns.

The mouldings, to which reference has already been made, have been plain, that is to say, the curves and hollows forming the section continue in parallel lines from end to end of the moulding. Mouldings may be themselves treated in a variety of ways to enhance their decorative value. They may be gilded and burnished, painted, carved, turned, waved or cross-banded with veneer. The earliest carved mouldings were enriched with patterns which grew naturally out of the vigorous use of carving tools of various shapes, notably, the gouge and V-tool. A high degree of elaboration was achieved by the use of the simplest elements.

Carved mouldings applied to furniture in the 18th Century followed very closely the traditional enrichments for the various mouldings used on the classic orders of architecture. The egg and dart enrichment for the ovolo, the water leaf for the ogee, the bead-and-reel for the fillet, and so on.

There is another type known as waved moulding, invented by a German named Schwanhardt about the beginning of the 17th Century. These undulating or waved mouldings were promptly adopted by French, Flemish, Spanish and Italian craftsmen, and became a feature of the ebony furniture of the period. They are used for the decoration of the Rubens cabinet in the Royal Collection at Windsor Castle, which is considered to be one of the finest pieces of ebony furniture existing. Waved mouldings were never employed extensively in Great Britain until about 1870, when they were re-introduced in the west of England for the decoration of cabinet work. Metal mouldings have also been used, notably by the French, for embellishing their fine furniture.

The metal-worker in France seems to have regarded furniture as a background of wood to be enriched with ormolu mounts and mouldings. There was also a practical reason for their use. Much of the finest French furniture was veneered, and the metal mouldings constituted a protection for the exterior angles. These metal mouldings were usually held in position by means of small brass pins which were chased over to render them invisible.

PIERCING.

From that brief résumé of the decoration of furniture by means of moulding, I turn to pierced work. This also probably had a utilitarian origin. The old livery cupboards were used for storing food, and ventilation was a necessity. Gothic woodworkers formed in the doors of their cupboards little traceried windows and these perforations provided the ventilation; in less ambitious pieces the circulation of air was obtained by the boring of small holes, which not only prevented the food from being tampered with by domestic animals, but kept out flies and other insects; the craftsman, instead of boring small holes at random, bored them in such a way as to make pleasant patterns and thus ornamented as well as ventilated the work.

During Renaissance times flat interlaced ornament was spoken of under the general heading of strap work. Stone parapets of great houses were often formed of open stone work, and this fashion was reflected in the woodwork of the period. A notable example of piercing is the ornament which surmounts the screen in the Hall of Wadham College, Oxford. Piercing was also used in the staircases, balusters and newels of the period. This method of decoration has been used extensively for embellishing chairs, doubtless because furniture which is moved constantly from one position to another should not be unduly heavy. The 18th Century chair makers used piercing extensively as a method of decoration, particularly after Chippendale's influence began to make itself felt. He commenced to lighten the fiddle-shaped splats in the backs of early Queen Anne chairs by piercing them. Later he turned his attention to designs in the Gothic manner, and elaborated the Chinese frets which became popular on the return of Sir William Chambers from the East. Piercing became almost an obsession with him, and he set a fashion for this form of decoration which culminated in designs that looked as if they had been prepared for execution in lace rather than in wood.

TURNING.

Turned decoration is a rather wider subject. Rings or annulets cut on the haft of the axe or club in order to give a firm grip, took, as civilisation progressed, a decorative form. Circular supports for a table, chair, couch, bed, or indeed any piece of furniture, are more practical in use than square ones. In the square support the exterior angles—the sharp corners—are particularly liable to be kicked and damaged in use, and it would occur quite naturally to a

thoughtful craftsman to chamfer the exterior angles, leaving the shaft more or less octagonal, and from the octagon to the circle the transition would have been a rapid one, quite apart from the fact that the lathe is one of the most primitive of tools. The majority of early turning consists of circular shafts with rings or annulets at more or less regular intervals. Rich effects are obtainable by the repetition of the simplest motifs. This is very marked in Byzantine work dating from the ninth to the twelfth centuries, and also in furniture of the Romanesque period. The craftsmen of the Renaissance developed the rudimentary turnings, and the simple rings on the surface of cylindrical shafts gave place to finely proportioned balusters, in which curves and hollows were contrasted in the most subtle way.

The turned work to which I have referred so far was used " in the round," being placed in position just as it left the lathe, but there is another method of using turned work which was largely employed in the 17th Century. The process was quite simple, the turnings were split in half and applied to flat surfaces of the woodwork. There is a theory that turned bosses, or to be more correct, half turned bosses, applied to the surfaces of panels, owe their origin as a decorative feature in woodwork to the use of jewels by contemporary goldsmiths. The jewellers prepared many of the precious stones used by them cabochon-wise—that is in simple rounded convex surfaces without facets, and the turned decoration to which I am now referring resembles a cabochon in wood.

The lattice screens largely used by Egyptian builders and furnishers are generally referred to as being of Cairene or Mushrabeeyeh work. These screens are made of an infinite number of small turnings most ingeniously fitted together to form a variety of geometric patterns. In Egypt this Cairene work is employed on the northern elevations of the houses to allow the ingress of cool air and to ensure the privacy of the women's apartments. It is also employed to obtain decorative effects in furniture.

Very beautiful turned work was made in Brittany to provide ventilation for the enclosed wooden beds, which were a feature of the interior architecture of farm buildings.

Twisting.

There is a subdivision of turning—twisting—those spiral supports which we associate in this country for the most part with Stuart furniture. Twisted work was wrought by hand before the introduction of the elaborate attachment which makes its production possible on a modern lathe. There are a number of varieties of twisted work, and this decorative feature is to be found over a very widespread area in Italy, France, Germany, Spain, Flanders, and Great Britain. On occasions the twisted form is amazingly complicated, as in such specimens as those which flank the doorway of the cathedral at Florence, and in the Cloisters of San Paulo. The twist as a form of ornamentation on furniture was fully developed on the Continent before it was introduced into England,

and the probability is that it found its way here after the restoration of Charles II and his marriage with Catherine of Braganza. Carved ebony furniture was, for instance, introduced at that time, and Evelyn notices in 1662 that the Queen brought over with her from Portugal "such Indian cabinets which had never before been seen here." Spiral turning was a feature of this Indo-Portuguese work, and chairs of this character at Windsor Castle, Knole and Penshurst, have spirally turned legs and stretchers. The quick succession of light and shade on spiral turnings forms a pleasant contrast to the flat surfaces of the veneered walnut furniture of the late Stuart period in England. Spiral columns were not only used as supports but were applied on the fronts or elevations of elaborate furniture during the Renaissance. The Dutch were very fond of this feature.

The twist has a variety of forms—the double twist, the open twist and the double open twist and many others. In the early 19th Century spiral turning became debased, and we associate it with heavy twisted bedposts and whatnots, devoid of any beauty of form or outline.

Carving.

I now turn to carving, which is the most natural method of decorating furniture, for in its simplest forms it derives directly from the tools used by the cabinet-maker or joiner in constructing the woodwork itself. It cannot be argued that carved decoration as applied to furniture serves any practical end other than to delight the eye, surely a sufficient aim in itself, but it should nevertheless be conditioned by utilitarian considerations, and in this connection the savage, whether by accident or design, followed the proper method and kept his carved enrichment very flat. Applied to the handles of adzes or the shafts of spears and other weapons, the flat decoration served slightly to roughen the surface and thus give a better grip. When applied to furniture, carving of any kind should be smooth in character where it is likely to be handled, and it is questionable whether carving in high relief is admissible from the strictly utilitarian point of view. The deep hollows of the undercutting become pockets to hold dust, and the tendency of modern furniture is to eliminate as far as possible any surface treatments which cannot be cleaned with ease. The virtual absence of carved detail in modern furniture is also due to the fact that much of it during recent years was lifeless, poor in execution, and had no definite relationship to the furniture to which it was applied. I use the expression "applied" advisedly, for much of it was actually stuck on. Primitive races and the craftsmen of the Gothic and Renaissance periods cut their carved decoration in the solid, thus ensuring a pleasant interplay and relationship between the pattern and the background. Various methods of simulating carving have been introduced. Wood specially prepared by laminating, or pulverised wood, mixed with a suitable adhesive, is forced into metal moulds under great pressure and supplied in quantities to take the place of hand-carved panels. Carving machines have also been used.

A third method is employed which has for its object the abolition of the labour involved in routing out the background, which is the first operation a carver must undertake when carving panels in relief. To lighten this preliminary work it is customary to cut out the pattern by means of a fretsaw from wood of the requisite thickness to give the desired relief and to apply this fretted ornament to the surface of the panel with glue, subjecting it, of course, to considerable pressure to make it adhere firmly. When withdrawn from the press the fretted ornament is of uniform thickness throughout with a ready-made background consisting of the level surface of the panel to which it is applied. The carver then works on this, being concerned only with the modelling of the ornament, the outline having been already formed for him by the fretsaw. This leads to all manner of incongruities: for instance, the wood used for the applied ornament may be different in colour, texture or the direction of the grain from that of the panel to which it is glued, and in order to minimise this incongruous effect the ground is punched all over to give it a stippled appearance vastly inferior to the sympathetic surface formed by the carving tool when the ornament was worked in the solid. Compared with such mechanical methods the flat, simple carved enrichments of the savage are wonderfully expressive. In some of the most charming carved decoration applied to furniture and utensils the relief is very low and the outlines are obtained by sinking the ground work round the design just enough to give definition. Carving is usually thought of as ornament in relief raised above the panel or surface which forms the background, but elaborate decoration may be produced by means of shallow sinkings, the ornament itself being flat.

During the decadent periods of furniture design, the carver assumed the role of the cabinet-maker. He was not called in to embellish, let us say, a side table, but actually to make it. What was ornament in the older styles assumes control, eats away form until form itself becomes ornament. It no longer represents the beautifying and perfecting of the common things of life, which is the function of decoration as applied to furniture, but bears witness to a life cut off from such things. It is indeed impossible to associate these creations with the idea of everyday life at all.

During Renaissance times the master carvers competed with the painters, and the front of an armoire or chest might contain half a dozen scenes from Biblical history sculptured in wood. I always find myself, when examining such pieces, looking at the individual panels rather than at the piece of furniture as a whole. The execution of the work was wonderful, but judged by modern standards the Renaissance people rather overdid their decoration. There is a chest preserved in the Museum in Stockholm in which the carved work is so intricate as to defeat its own object; it merely becomes a confused breaking of the surface, and loses all clear definition.

The term carving covers a technique which consists of mere rudimentary scratchings on the surface of the wood at one end of the scale and the beautiful and elaborate naturalistic work of Grinling Gibbons at the other.

FINSBURY TECHNICAL COLLEGE.

All who are interested in technical education will hear with regret that Finsbury Technical College was closed finally on July 26th. Founded in 1878, this College was the pioneer of technical education in England, and carried on a very successful work. Many famous scientific men, such as Ayrton, Perry, Armstrong, Meldola and S. P. Thompson were associated with the College in its early stages, and introduced courses of instruction in applied science which served as models to the numerous institutions which were founded at a later date for the purposes of technical instruction. Silvanus P. Thompson was principal of the College from 1885 until his death in 1916, and will be remembered as a gifted lecturer, and a man of unusual attainments in many branches of knowledge. His students occupy important positions all over the world, and hold his memory in the highest respect. He and other members of the staff frequently read papers, and delivered lectures on scientific subjects before the Society.

The chief reason for closing the College was lack of funds. Until 1921 it was entirely financed by the City and Guilds of London Institute, which, owing to the increase in all-round costs following the War, found itself unable to provide the sum needed for the upkeep of the College. Temporary financial aid from the London County Council enabled the College to carry on its work until the present year, but with the withdrawal of the L.C.C. subsidy no option was left but to close down. It is greatly to be deplored that an institution with such a distinguished record should be allowed to perish from want of funds, and the closing of the College will be greatly regretted by scientific men all over the world.

LIKIN—CHINA'S INLAND TRADE TAX.

In view of the International Tariff Conference convened at Peking to consider a new schedule of effective tariff duties in China based upon the abolition of likin, the following historical account of the institution and levying of this inland trade tax may be of interest. The particulars given are extracted from a memorandum prepared by an official of the United States Department of Commerce :—

Likin—the tax on goods in transit inland throughout China—was first imposed in 1853, in Kiangsu and Shantung Provinces, as an emergency measure to provide funds for putting down the Taiping rebellion ; but with the rise of the Muhammedan rebellion in 1861 it was extended throughout the Empire and has remained in force for 73 years.

Likin, however, long since ceased to be a source of any important revenue to the Central Government. The agents formerly appointed by Imperial decree to collect it have been superseded by the "tuchuns," or provincial governors, in whose hands it has become almost the only important source of provincial revenue ; and this has accounted for the steadfast maintenance of likin, in spite of general agreement that it is one of the most detrimental of the factors affecting trade in China, and that every commercial treaty with China for a quarter of a century has aimed at bringing about its abolition.

The term is now used to designate any or all forms of inland taxation on merchandise in transit, but originally it applied only to a special tax of one-tenth of 1 per cent. ad valorem, which was levied on goods each time they passed certain fixed tax stations, or likin barriers. It is made up of the two characters "li," the one-thousandth part of a tael or ounce of silver, and "chin," a tithe, literally of metal or gold. The term "li-chuan" is also used : the collector, affecting to

view the payment of dues by the merchant as a contribution, calls it li-chuan; while he merchant looks at the hard cash he has to pay out and calls it likin, a percentage in silver.

Likin barriers exist at all considerable towns and are placed along the main routes of interior trade, by both land and water, sometimes at intervals of 20 miles or less. Originally they were so arranged that a payment of one-tenth of 1 per cent. ad valorem at each could not total more than 5 per cent. in any one Province, although goods passing through several Provinces might be taxed to 10 or 15 per cent., or even more. In practice likin soon came to exceed 5 per cent. per Province, and in Kiangsi it rose to as much as 15 to 20 per cent.

Both Ad Valorem and Specific Bases Used.

At the outset likin was imposed solely ad valorem, later on a specific basis, and to-day both bases are used. The ad valorem rate per barrier has changed from one-tenth of 1 per cent. to an average of 2 per cent., in some sections to as high as 5 per cent. Charges, however, vary. In four cases in Kiangsi the same kind of goods paid over the same route to Shanghai, in one instance a total of 2.2 per cent., in another 3.7 per cent., in a third 3.9 per cent., and in the fourth 7.5 per cent.

In 1921 the number of recognised tax barriers distributed throughout China totalled 735. Each of these barriers has, moreover, a number of sub-stations where merchandise is stopped and taxes are collected. Indeed, every village of any consequence in China has a tax-collecting station of some sort, and the total number will run into thousands. At any or all of them various forms of internal taxes are collected, each masquerading under the general term "likin," but in reality possessing a separate identity. Some are substitutes for likin, some are supplementary to it, some are of a wholly independent order.

Among the substitute taxes is the "t'ung chuan," or blanket tax, and the "t'ung shui," devised for relief from the exactions of likin. The merchant pays about 5 per cent. at the first barrier in each Province and is presumed thereafter to be relieved of taxation at subsequent barriers. His goods, nevertheless, are subjected to "examination" at the other barriers, and the examination fee, coupled with the delay entailed, often imposes a tax on the goods hardly less than the ordinary likin charges. Eight Provinces of China have adopted t'ung shui, which is little if any improvement upon likin.

In addition there are the production and/or shipment taxes imposed at the point of departure, and a consumption and/or sale tax at the station of destination. Each of these amounts usually to 2½ per cent. ad valorem, their total often reaching 10 per cent. These taxes are most in vogue in the three Eastern or Manchurian Provinces, but they are also met with elsewhere.

Loti-shui, or the destination tax, is levied almost everywhere in the interior on foreign goods when they come into the hands of the ultimate Chinese merchant who is to distribute them. Although they may have been shipped under the transit pass system—whereby, having paid to the Maritime Customs at the port of departure an additional 2½ per cent. ad valorem duty, they are legally relieved from any other dues or taxes whatsoever—the merchant is usually obliged to submit to the charge of loti-shui. Otherwise collection may be imposed by force. The reason is simple: the transit dues being turned over to the Central Government, the provincial authorities have received no part of them; but as the goods have come into their territory for sale, they feel justly entitled to a tithe in them.

Lump-sum payments in lieu of likin are also made, often in exchange for immunity from some other exaction.

It is no uncommon practice in parts of China for one having possessions which he fears may fall into the hands of robbers, or independent military bands, to pay the first of these encountered a sufficient sum to assure its escort and protection against other bands. Lesser forms of taxation almost universally applied are boat taxes in great variety, tonnage and port dues, special taxes on wines and tobacco, and the monopoly or hong taxes, which are usually paid through the merchant's guild. These are often imposed upon commodities entering into foreign trade, which have complied with the provisions of the treaties, as well as upon domestic trade, which enjoys no treaty immunities.

It is extremely difficult to obtain even approximate figures for the amount of likin collected throughout China. According to a report of the Ministry of the Interior during Yuan Shih-Kai's régime, the likin revenue, as reported to the Central Government in 1912, amounted to 36,584,005 Mexican dollars. (1 Mexican dollar = approximately 2*s*. 0½*d*.) According to more recent figures, the estimated amount of likin collected in each Province during 1920 was as follows :—

	Mexican dollars.		Mexican dollars.
Anhwei	1,599,412	Kirin	1,267,087
Chekiang	4,225,532	Kwangsi	982,784
Chihli	681,225	Kwangtung	2,545,568
Fengtien	4,169,733	Kweichow	525,561
Fukien*	1,633,000	Shansi	632,504
Heilungkiang	537,087	Shantung	227,888
Honan	615,553	Shensi	933,791
Hunan*	2,700,000	Sinkiang	391,079
Hupeh	5,049,819	Szechuan	636,987
Kansu	995,806	Yunnan	400,000
Kaingsi	5,791,113		
Kiangsu*	6,358,972	Total	42,891,501

* Estimates for 1922 ; all others 1920.

These figures sufficiently indicate that the average annual revenue from likin is certainly in excess of 40,000,000 Mexican dollars, but there is no doubt that such a sum is far under the total actually collected from the merchants, who pay some form of likin on every dollar's worth of goods that passes from place to place in China. It is not possible to measure with precision the total volume of China's domestic trade, that vast traffic of junks, carts, camels, man pack and mule pack carried on inland, from town to town and Province to Province, far beyond the railways and coasting vessels—all of which pays likin. The trade of 400,000,000 people between themselves, however, must be of an aggregate value and volume much in excess of their foreign trade ; especially where there are no highly developed forms of industrialism and the routes to ports are few in number, of primitive development, and traverse great distances. In the United States the ratio of value of the domestic trade to that of foreign trade is about 5½ to 1. In China the difference would not be so great, but it might not be unreasonable to assume it as at least 2 to 1.

If this assumption is accepted and 1922 taken as a typical annual period, for which all figures have been fully compiled, it is found that the value of China's total foreign trade for that year, both import and export, was in round figures 1,600,000,000 haikwan taels, and the domestic trade, therefore, may be reckoned at 3,200,000,000 taels ; or the total value of China's whole trade, 4,800,000,000 haikwan taels—12 taels, about £2, per head, an estimate that seems well in line with known facts.

Upon all this domestic trade, and on much of the foreign, too, likin is collected, at an average rate, according to authoritative observers, of 2 per cent. ad valorem per barrier; and in some Provinces or over long trade routes the taxes have aggregated as much as 10, 15, and even 20 per cent. ad valorem. If the domestic trade alone has passed an average of but one likin barrier, or paid but once the average rate it has paid 2 per cent. of 3,200,000,000 taels, or 64,000,000 taels, or more than twice the average collections as officially reported. If, however, certain observers' conclusions are well founded—that total likin collections will average 5 per cent. ad valorem for the country—then the aggregate reaches 160,000,000 haikwan taels.

The foregoing calculations, it should be noted, do not include likin contributed by foreign trade. Since in 1922 the total transit dues collected amounted to only 3,097,013 haikwan taels, on a 2.5 per cent. basis, while the customs duties paid approximated 60,000,000, on a 5 per cent. basis, it is apparent that foreign trade must have paid in likin, at an average of 5 per cent., a sum not so very far short of the difference between what it paid in transit dues and in customs dues. This sum, if placed as low as 40,000,000 taels, and added to that paid by domestic trade, makes a total of 200,000,000 taels (or 300,000,000 Mexican dollars) for likin collected on China's whole trade in 1922.

One singular fact with regard to likin and its relation to the foreigner trading in China should, perhaps, be mentioned. It is that although likin is so generally recognized as one of the serious detriments to trade development in China, as a matter of fact, comparatively few foreign merchants have ever been conscious of it, except from hearsay. The foreigner customarily sells his goods at the treaty ports and takes his profits. Or, generally, he has bought them delivered there, only after he was sure he could sell again at a profit. It is the Chinese merchant who loads the goods on to freight car, steamer, junk, mule pack, or man pack, and contrives them as best he may through the barriers, enduring at each succeeding one new charges and new vexations that may bring him to the end of his journey faced with a heavy loss—which at no time on the road had he ever an opportunity of avoiding.

RADIUM PRODUCTION IN BELGIUM.

About four-fifths of the world supply of radium is now produced in Belgium. From the report of the Commercial Secretary to H.M. Embassy at Brussels it appears that in 1915 the *Union Minière du Haut Katanga* began working the rich uranium deposits in the Belgian Congo. The ore is shipped to Belgium and worked up at the company's factory at Oolen, near Antwerp, at which operations were started two years ago. The output is limited to the demand, and is approximately 20 grammes per year.

UNIVERSAL EXHIBITION IN BELGIUM IN 1930.

According to the annual report of the Commercial Secretary to H.M. Embassy at Brussels, preliminary arrangements for a universal exhibition to be held in Belgium in 1930 are well advanced. It is at present decided that there are to be two sections. The main section will be at Brussels, whilst the colonial and marine section will be at Antwerp. There is a further proposal for a section at Liége, but on this point no decision has at present been reached.

Both at Brussels and Antwerp powerful committees have been formed and the necessary capital funds subscribed.

TRADE CONDITIONS IN THE REPUBLIC OF SALVADOR.

Notwithstanding the very high rates of customs duties imposed on all classes of goods by the necessity of creating a large revenue and liquidating the American loan in due season, general trade conditions in the Republic of Salvador may be described as highly satisfactory and continuously improving.

According to the recently published report by the Acting British Consul at San Salvador, the country is attaining a degree of prosperity, luxury and stability hitherto unknown in its history and the factor of price does not appear to interfere in any way with the purchasing proclivities of the monied class. The appearance of really good paved roads and ferro-concrete houses of an "earthquake-proof" type is creating an urge for the expression of new-born expensive tastes and luxury of living. There is a consequent inflation of the demand for personal and household requisites of a more refined type, a desire for improved and faster means of locomotion and for the hundred and one necessities of European and North-American life which hitherto had seemed superfluous, if not actually unattainable in Salvador. Education, which is being made practically compulsory by the present Presidential Administration, is teaching the masses to spend money on their homes and persons (as well as giving them the means of improving their earning capacity) much to the general benefit of both, and to the increase of trade.

With the stabilization of exchange, the import trade is beginning to recover from the set-back of recent years, and, although merchants are still rather prone to buy only for immediate and known requirements rather than with a view to the filling of stock and development of new lines, official statistics show that imports have more than recovered from the depression of 1922.

Import and export values for the last three years are as follows :—

Year.	Imports. U.S. dollars.	Exports. U.S. dollars.
1922	7,427,000	16,214,000
1923	8,770,500	17,058,000
1924	11,453,500	24,367,500

The import figures for 1923 and 1924 are incomplete, as they do not include imports by parcels post (which amounted to almost $2,000,000 in 1923).

While the geographical position of the United States of America makes that country the logical centre of supply for the requirements of the Republic of Salvador, and certainly does secure for it the majority of trade, there is, says the Acting Consul, no real reason why British goods should not be imported more largely than they are at the present time. True, the technical education of the average Salvadorean tends to incline his choice towards American products, but an appreciation of certain categories of United Kingdom manufactures is not lacking.

People will not, however, buy goods about which they know nothing, and every effort must be made to educate the actual consumer, more even than the merchant, to the excellencies of British products.

Some lines of British goods which might be usefully introduced or pushed more vigorously on the Salvador market are agricultural machinery, bicycles, boot polishes, confectionery, disinfectants, dyestuffs, fancy goods, fencing wire and fencing, haberdashery, household requisites, kitchen utensils, motor-cycles, novelties, office requisites, paper manufactures of all kinds, perfumed soaps, perfumery and cosmetics, pharmaceutical specialities, photographic apparatus, porcelain and china, rubber goods, including tyres, small tools and toys.

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Modern Colour Problems. Three Lectures. By LOUIS C. MARTIN, D.Sc., A.R.C.S., D.I.C., F.R.A.S. (1925.) Price 2s.

(Howard Lectures.) Motor Fuels. Three Lectures By Professor J. S. S. BRAME, F.I.C., F.C.S (1925.) Price 1s. 6d.

Radiological Research—a History. Three Lectures. (By V. E. PULLIN. (1925.) Price 2s.

The Inner Structure of Alloys. Three Lectures. By WALTER ROSENHAIN, D.Sc., F.R.S. (1925.) Price 2s.

Copies of the above lectures can be obtained from the Secretary Royal Society of Arts.

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All communications for the Society should be addressed to the Secretary, John Street. Adelphi, W.C. (2.)

NOTICES.

DINNER TO PROFESSOR SABATIER.

The Council of the Royal Society of Arts entertained Professor Paul Sabatier to dinner at the Athenaeum on July 22nd, on the occasion of the presentation of the Society's Albert Medal to him by H.R.H. the Duke of Connaught, when the following were present:—

Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S. (Chairman of the Council) in the Chair, Lord Askwith, K.C.B., K.C., D.C.L., Mr. Llewelyn B. Atkinson, Professor H. B. Baker, C.B.E., D.Sc., F.R.S. (President of the Chemical Society), Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I., Captain Sir Arthur W. Clarke, K.B.E., Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., Rear-Admiral James de Courcy Hamilton, M.V.O., Sir Herbert Jackson, K.B.E., F.R.S., Major Sir Humphrey Leggett, R.E., D.S.O., Sir Philip Magnus, Bt., Sir Reginald A. Mant, K.C.I.E., C.S.I., Mr. G. K. Menzies (Secretary of the Society), Colonel Sir Frederic L. Nathan, K.B.E., (President of the Society of Chemical Engineers), the Hon Sir Charles A. Parsons, K.C.B., LL.D., D.Sc., F.R.S., Sir Richard Redmayne, K.C.B., Sir George Sutton, Bt., Mr. Alan A. Campbell Swinton, F.R.S., Lt.-Colonel Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., and Mr. W. J. U. Woolcock, C.B.E. (President of the Society of Chemical Industry).

In proposing the health of the Albert Medallist the Chairman, after referring to the way in which Professor Sabatier's earlier work on the catalytic action of finely divided nickel in effecting the hydrogenation of acetylene had been extended and formed a new chapter in physical chemistry, said:

"The purely scientific results which aroused general interest have been followed by industrial applications in ways that were not fully anticipated, but are still extending with results of importance that cannot yet be estimated; for the hydrogenation of coal has not yet reached the stage, which it inevitably will reach, of meeting the increased demand for the liquid hydrocarbons now obtained from our oilfields.

There are scientific men who are revered for their discoveries in pure science although these may not have any direct economic value, and there are discoveries made by industrialists, which are found to be commercially valuable, but are incapable of development, because they are purely empirical and devoid of recognisable scientific basis. It is but rarely that a discovery is made which at once reforms scientific theory and opens up a new field in industry. Professor Sabatier's development of the action of catalysts is among these doubly valuable epoch-making incidents in the history of science.

Although his work on catalysis is to the outside world the outstanding feature of his record, he has carried his researches with distinction into other branches of chemistry, and, as Dean of the Faculty of Science at Toulouse, has shown a practical interest in other branches of culture, which has established his esteem in the educational world.

The Council of the Royal Society of Arts, in recommending His Royal Highness the President to add Professor Sabatier's name to the distinguished list, which includes those of Dumas, Pasteur and Madame Curie, has adhered to its custom to reserve this award, not for general excellence in the applied sciences, but for some outstanding work that marks a new era in scientific progress—work of the kind that can be illustrated by such names as Faraday, Joule, Hooker, Lister and Sir Charles Parsons, whose active interest in the work of the Society is shown by his presence to greet the new medallist."

In reply to the toast Professor Sabatier said :

" Monsieur le Président, Messieurs : Je regrette vivement de ne pouvoir répondre en Anglais aux paroles trop aimables que vient de m'adresser Sir Thomas Holland ; mais je tiens à vous remercier de l'honneur inestimable que vous m'avez procuré, ainsi que de la gracieuse invitation à ce banquet. Chacun de mes voyages en Angleterre a augmenté mes sympathies pour elle. Le chimiste Gladstone que j'avais rencontré en France dans plusieurs Congrès m'avait fait inviter au Congrès de la British Association à Oxford en 1894, où je reçus la plus cordiale hospitalité. Ce fut une session mémorable dans laquelle Lord Rayleigh et Ramsay vinrent annoncer la présence inattendue dans l'air d'un elément encore inconnu, l'argon. C'est là que je formai avec Sir William Ramsay les liens d'amitié qui ne cessèrent de se renforcer dans les circonstances nombreuses où je le rencontrai, au Congrès de Paris en 1900, à ceux de Berlin et de Rome en 1903 et 1906, etc. En 1914, quelques semaines avant la guerre, il presida l'une des deux conférences que je fis à l'Université de Londres. Depuis lors, j'ai été comblé d'honneurs par l'Angleterre : en 1915, je recevais le médaille Davy ; en 1918 la Royal Society me conférait le titre de membre étranger ; plus recemment je devenais membre d'honneur de la Chemical Society ; et voici que vous m'accordez une nouvelle distinction précieuse entre toutes, dont la liste des titulaires proclame l'immense valeur ! Elle symbolise à mes yeux l'union nécessaire et éminemment féconde de la science pure et de l'industrie, parce que les grands progrès derivent à la fois de l'une et de l'autre. Quand il y a quelque vingt-cinq ans, j'ai commencé mes travaux sur la catalyse, ceux qui m'ont valu le prix Nobel et aujourd'hui la medaille Albert, je n'avais en vue que des recherches purement théoriques ; je ne prévoyais pas qu'il pût en résulter des applications pratiques, et je ne songeai aucunement à breveter le principe de l'hydrogenation catalytique sur le nickel divisé, ce qui m'aurait procuré sans doute des bénéfices importants. L'intérêt pratique en apparut tout de suite à certains industriels. La fabrique Crossley à Warrington aperçut l'application qu'on pourrait en faire aux corps gras liquides. Elle me demanda quelques directives, et ne tarda pas à créer cette industrie nouvelle de l'hydrogenation des huiles qui à partir d'huiles de poisson d'odeur désagréable permet de préparer des graisses comestibles, et à multiplier ses usines dans le monde entier. Et de même que l'industrie profite de la science pure, de même la science pure profite aussi par l'industrie, qui fréquemment sait lui ouvrir des chemins inattendus. Messieurs, je lève mon verre a cette union indispensable entre le laboratoire et l'usine. Je bois à votre Société et à vous tous ; je bois à la Science Anglaise dont les conquêtes récentes sont si éclatantes dans la physique moleculaire ; je bois à l'amitié de l'Angleterre et de la France."

INDIAN SECTION.

A meeting of the Indian Section Committee was held on Friday, July 30th, to consider the arrangements for meetings of the Indian Section during the forthcoming session.

Present: Sir Edward A. Gait, K.C.S.I., C.I.E., (Chairman of the Committee), in the Chair; Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S. (Chairman of the Council); Sir Charles H. Armstrong; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Mr. W. Coldstream, I.C.S. (retd.); Sir Henry Ledgard; Mr. T. McMorran; Major H. Blake Taylor, C.B.E.; and Lt.-Col. Sir Arnold Talbot Wilson, K.C.S.I., C.I.E., C.M.G., D.S.O., with Mr. G. K. Menzies M.A., Secretary of the Society, and Mr. W. Perry, B.A., Secretary of the Indian and Dominions and Colonies Sections.

DOMINIONS AND COLONIES SECTION.

A meeting of the Dominions and Colonies Section Committee was held on Friday, July 30th, to consider the arrangements for meetings of the Dominions and Colonies Section during the forthcoming session.

Present: Major Sir Humphrey Leggett, R.E., D.S.O. (Chairman of the Committee), in the Chair; Sir Thomas H. Holland, K.C.S.I., K.C.I.E. D.Sc., F.R.S. (Chairman of the Council); Sir Charles Metcalfe, Bt.; Mr. Charles Ponsonby; and Major H. Blake Taylor, C.B.E., with Mr. G. K. Menzies M.A., Secretary of the Society, and Mr. W. Perry, B.A., Secretary of the Indian and Dominions and Colonies Sections.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE DECORATION OF FURNITURE.

By H. P. Shapland, A.R.I.B.A.,
Editor of the *Cabinetmaker*.

Lecture II.—*Delivered January 25th*, 1926.

Veneering.

Five methods of decorating furniture have already been described, each of the five being concerned with the manipulation of the wood of which the furniture itself is made, either by means of moulding, piercing, turning, twisting or carving. Furniture may also be decorated by the surface application of a variety of materials; some details of the processes employed in veneering, inlaid work or marqueterie, gilding and painting, therefore follow.

There is perhaps no method of decorating furniture so little understood by the general public as veneering. It is widely supposed to be a questionable practice—the covering of an inferior material by some better material. Perhaps this is because the word has a double meaning. We may, for example, say of a man, "His goodness is a mere *veneer* to cover up his meanness." The idea may have gained currency also from references in such books as "Our Mutual Friend," in which Dickens described Mr. and Mrs. Veneering. Dickens gave a wonderfully clever description of them, but the impression left on the mind of the reader was that Mr. Veneering was an insincere, shoddy sort of man, and, through the association of ideas, that veneering was a shoddy kind of process. However it may have arisen, there was a widespread belief at the end of the 19th century that veneered furniture was poor furniture. This is entirely erroneous and is disproved by the fact that the great 18th Century cabinet makers in Great Britain and France used this decorative method and that their work has stood the most exacting test of all, that of time, and come through the test quite triumphantly. We can go back a great deal further. Tutankamen's tomb contained beautifully made boxes veneered with choice woods, ivory and gold.

Veneer is wood cut into very thin sheets by using a saw or a knife. When baulks of timber are sawn, in the majority of instances the wood is comparatively plain, but occasionally a baulk (one in a hundred) may be characterised by beautiful figure or grain—so beautiful and so rare that it would be foolish in the extreme to cut it into planks and make furniture of it in the ordinary way; quite as foolish as constructing a piece of furniture from solid ivory, if that were possible, instead of overlaying it with ivory as is sometimes done.

There are also certain timbers which are not at all suitable for constructional purposes, but are beautiful in grain and colour when used as veneers. What is known as oystershell veneer is cut at right angles to the length of the trunks of small trees, such as the laburnum. English figured walnut, which has been used so extensively for veneering, is not very satisfactory as a constructional material on account of its tendency to warp and twist, but it is a wood which is indispensable for the surface decoration of furniture. The greatest care is necessary in preparing the groundwork of panels or doors which are subsequently to be treated with veneer. The slightest shrinking, warping, twisting, or opening of the joints, will be apparent in the veneered surface, and unusual precautions are taken to guard against such faults. Undoubtedly the best solid core for veneering upon is quartered whitewood, thoroughly dry and straight, or for very high class work quartered Honduras mahogany.

Veneers reach the cabinet maker from the veneer merchant looking rather like a solid plank or baulk, which in reality consists of a great number of thin sheets of wood. Some of the most attractive decorative effects in veneering are obtained by halving and quartering these veneers so that the markings form a pleasant pattern. It will be obvious that the grain in any sheet of

veneer is very similar to that of the sheets lying immediately above or below it in the same baulk, and it is this which enables the skilled cabinet maker to obtain delightful effects by the simple expedient of taking two adjacent veneers, cutting them down the centre and disposing them in such a way that the markings are symmetrical on either side of a central line. When quartering, each quarter must be taken from the same stock of veneers, and the lines of the grain carefully matched so that they meet. Success in this method of using veneers depends entirely on the careful planning and the matching of the markings in the wood as closely as possible. Oak, walnut, mahogany, satinwood, and sycamore may all be halved and quartered in this way. Effects are obtained by means of the natural pattern formed by the grain, and also by the use of lines or bands of veneer which are used in such a way as to form borders. Individual sheets of knife-cut veneer are little thicker than paper. Long experience leads experts to the conclusion that 1/28 or 1/30 of an inch is the right thickness for a knife-cut veneer. Much care is necessary in cleaning up the work with the scraper or sandpaper in order to avoid the risk of making holes and spoiling the surface.

Wood is sawn into veneers when it is too hard or two curly in the grain to be cut with the knife. A very thin and very large circular saw is used with a diameter of 12 to 18 feet. But even so there is a great deal of waste, as about half the valuable wood is lost in sawdust. Veneered furniture is generally characterised by a certain squareness and formality, the aim of the cabinet maker being to obtain continuous surfaces on which the colour and graining or mottling of the veneer may be displayed to the greatest advantage. The decoration of furniture by this process is really evidence of the cabinet maker's appreciation of the beauty of the material in which he is working. The French exercise extreme skill in their use of veneers. With them it is not so much a question of the application of veneers to straight surfaces but to the bombé or curved surfaces which they use to a far greater extent than we do in this country in their furniture designs.

Inlay or Marqueterie.

The inlaying of one material into another is of great antiquity. Furniture treated in this way is found in the tombs of Egypt, and craftsmen in primitive communities have used inlays to decorate their weapons and implements. In much of the earliest work a black and white effect was aimed at. It is difficult to dissociate the inlaying of wood from the damascening of metals in the East and Spain. There is a curious link between the two processes in a type of inlay found in India, which consists of a metal wire inlaid in a background of dark wood, which produces a light pattern on a dark ground. In Gothic times there was little inlay or marqueterie. Builders and joiners then relied upon carving, gilding and painting, but the Renaissance workers made the fullest

possible use of it. This is quite natural, for the process was well known to the Greeks and Romans from whose work they derived their inspiration.

The terms inlay and marqueterie are at present used rather loosely and perhaps need some definition. Strictly speaking, inlaid work should be regarded as the technique which consists of forming slight sinkings of an eighth or a quarter of an inch deep in the solid wood, and then filling the hollows made with woods of a different colour, cut to fit them.

Marqueterie is a later development and is closely bound up with veneering. In marqueterie the ornament is first formed in a thin sheet of wood or veneer, and subsequently the veneer and ornament, as one sheet, is applied to the surface of the wood.

There is a third term, *intarsia*, and that again is rather loosely applied; I think it should be used to designate those pictorial effects in wood in which the craftsman used the utmost skill and chose his material with the greatest care, in order to vie as far as possible with the work of painters.

Marqueterie at the present day is produced by means of a fret saw, but the machine used is very different from either the hand-saw or treadle machine which we all used as boys. There are various methods of transferring the design to the wood. When this has been done, the pieces comprising the ornament to be inlaid and the veneer which will form the background are sometimes sawn together at one operation. The French, with their great exactitude in craftsmanship, realise that by this process the fitting cannot be absolutely exact, because the thickness of the saw leaves a tiny margin round the ornament which does not therefore exactly fit the background. They therefore saw the ornament and background separately, making due allowance for the thickness of the saw; this is one of the reasons which accounts for the great technical perfection of their inlaid work.

Inlays and veneers are rarely cut singly. It is not advisable to cut less than three at once, and as many as six may be cut without detriment to the work. A piece of veneer of whitewood or any other inferior wood is placed at the back of the more costly woods to avoid the burring and breaking away of the edges caused by the saw. By this means the edges of the veneers themselves are kept sharp and clean. In the event of only one piece of marqueterie being required, the veneer is placed between two inferior veneers, because in practice it is found that a good clean outline cannot be made in one piece of veneer when cut without any support. Apart from this, a single veneer is rarely, if ever, strong enough to withstand the action of the saw without damage. The veneers are held together with special fine steel pins, but before being driven through the points are nipped off to prevent splitting the wood. To the materials used for marqueterie there is practically no limit, and the shades obtainable in natural woods range from black, warm browns, reds and yellows, to the white of sycamore and holly. This choice of colour is augmented by dyed woods of all kinds. The tendency of all woods, when exposed to light and air, is to become a little

paler and more mellow in tone. Hence the introduction of any material such as mother-of-pearl, which does not mellow with time, must be carefully considered if a spotty unequal effect is to be avoided. Ivory and bone were both used with discrimination by the Italians, notably in the decoration of their musical instruments. The individual pieces of the pattern—foliage, petals of flowers, the folds of drapery—are sometimes shaded to give interest and definition to the work. This is done as follows: Before the pieces are inserted into the veneer which forms the background they are browned or scorched by placing them for a few minutes in hot silver sand. This is put on a metal plate over a gas ring, and when the sand is sufficiently hot the piece of veneer is placed face downwards gently into the hot sand and withdrawn repeatedly in order to ensure that the shading is not overdone. The sand becomes so hot that a pair of tweezers is needed for this work. The shading should not take the place of a careful selection of woods, for marqueterie should depend as much as possible for its effect on the varied markings and colours of the woods in their natural state.

The work has now reached a stage when we have a ground consisting of a sheet of veneer pierced to take the ornamental pattern, and a great number of separate pieces of veneer cut exactly to fit the space left in the ground: it is now necessary to put the work together. In order to do this the veneer which forms the ground should be pinned to a piece of wood slightly larger than the out to out dimensions of the work, with a piece of paper inserted between the veneer and the wood. In the spaces in the groundwork left for the ornament a little gum is brushed, just enough to hold a few pieces of the pattern. When these are placed in position another patch can be gummed, and the task of fitting in the small pieces resumed. As the work progresses it is advisable to place flat lead weights of a handy size upon the work, more especially on the larger pieces of the ornament which have been placed in position. When completed thin glue mixed with some of the fine sawdust from the cutting of the groundwork is rubbed in round the joints. This is invariably done, even in the finest work, otherwise there would not be the necessary cohesion between the ground and the ornament to allow of its being handled before it is finally laid in position. The glue on the surface is not allowed to set but is scraped off immediately, and a piece of paper is gummed over the whole of the upper side of the work. The next step is to clean off the paper from the back of the veneer (that which was on the underside when the separate pieces were being gummed into position) leaving the sheet of paper which was last applied, which should remain on that side of the work which will be uppermost when the inlaid veneer is laid on the panel or piece of furniture which it will ultimately serve to decorate.

Engraving is sometimes resorted to on the surface of marqueterie, but the best compositions of the Italian workmen prove that it is unnecessary even when portraying the human figure. When the process is employed, the work

is done after the first coat of polish has been applied. In the best work cross hatching is avoided. When the engraving is complete the lines are filled with melted mastic, to which is added black, vermilion or any other desired colour. This, after being well rubbed in, is left to set hard and then carefully cleaned off.

GILDING.

Gilding is frequently employed in the decoration of furniture. Gold is used either to cover the work entirely or it may be partially applied, the mouldings, carvings, and other decorative features only being treated. The process is one which needs experience, skill, and, in the final stages, great deftness in handling the gold leaf. The furniture which is to be gilded is first prepared by coating it several times with a mixture of gilder's whitening and size. The number of coats of whitening depends upon the nature of the wood, but the aim is to get a perfectly smooth and even surface. In cases where joints might be likely to open with age or wear the careful gilder covers them with woven silk when applying the first coat of whitening. Each successive coat is allowed to dry very thoroughly, and the work is then subjected to a process known as drawing up and smoothing in water; this needs considerable care and experience, as upon it depends the ultimate effect of the gilding. A layer of gilder's clay and size is then applied with a brush. When the coating of clay is absolutely dry, a coating of burnished gold size is applied to those parts of the work which will be burnished subsequent to the application of the gold, and in modern practice those parts which will remain matt are treated with matt gold size.

The burnished gold size is made in two colours, red and blue. The Germans almost invariably use blue, while the French employ red, but there is no such hard and fast distinction either in England or Italy, where red and blue are employed indiscriminately.

The burnished gold size being thoroughly dry, the work is ready for the application of the gold leaf. The leaf is placed on a gilder's cushion, which consists of a piece of board about 10 in. by 5 in., the top being covered with a soft leather pad on which the gold is cut with a gilder's knife. One half of the gilder's pad has parchment sides so arranged that they stand about 3 in. above the surface to prevent particles of gold from falling when the gilder flattens the leaf on the pad by gently blowing on it. The gold leaf having been spread quite flat by this means, the gilder cuts it to the size he requires. The portion of the leaf to be applied to the work is lifted from the pad by means of a flat camel-hair brush about as wide as a man's hand, the tip of which the gilder passes through his hair before picking up the gold leaf. The leaf readily adheres to the brush. The position to which it is to be applied having been previously moistened with water, the gold leaf is placed on it. When quite dry the leaf is rubbed with a burnisher made of agate.

All fine furniture, both past and present, is water gilt in this manner, but in less expensive work gold is applied to those parts of the work, which will not

be subsequently burnished, by means of oil gold size. For instance, in carving consisting of prominent foliage with deep hollows the high lights would be water gilt and burnished, and in the hollows, where the gold would remain matt, it would be applied not by means of water, but an oil gold size.

Gold leaf is supplied by the beaters in many colours, ranging from white and very pale yellow to deep gold. Gold of a pale green shade is also obtainable.

In German gilding different materials are employed. The building-up process, the employment of whitening and size, gilder's clay and size, etc., is just as has been already described, but instead of gold leaf silver leaf is applied, treated if desired with a burnisher, and then lacquered with a gold-coloured lacquer to give it as far as possible the appearance of genuine gilding. A less expensive method still is to gild the parts that are to remain matt with some metal other than silver or gold and to treat the parts that are to be burnished with silver. What is known as "German gilding" is inexpensive and effective, but it does not compare favourably in appearance with the gilding which is produced by the application of gold leaf.

PAINTING.

The painting of woodwork was general during the Gothic period, and traces of it may be found in many ecclesiastical buildings, but specimens of early English furniture painted in bright colours have mostly perished. Some indication of the way in which woodwork was treated may be gathered from the wooden canopy which remains over the tomb of the Black Prince in Canterbury Cathedral, and the tradition survives in connection with the craft of wagon building. In country districts the wagon builder still finishes his work in the brightest reds and blues and yellows, and can usually ascribe no other reason for the choice of the colours he employs than that wagons have always been painted in that way.

Painting in the ordinary sense is used still in many country districts for furniture. It is not unusual in the parlours of country inns—a settle and occasionally chairs and tables are painted some plain colour, green, blue or brown and repainted when soiled with use. Graining is simply the painting of furniture in imitation of the markings of oak, maple, walnut, mahogany or other hard woods. In the hands of a skilful grainer the feather and curl of mahogany and the characteristic markings of maple and oak may be very closely copied. The treatment has fallen into disuse except for inexpensive furniture. In passing it should be noted that not only wood but marble was imitated by furniture makers in the 18th Century. In Switzerland, the Tyrol, and some parts of Bavaria, furniture which had already been coated with paint was further decorated by means of free brushwork scrolls and floral and animal forms, some of them quaintly conventionalised. Painting is also used to imitate other methods of decoration. There is a wardrobe in the Museum at Hamburg dating from the earliest years of the 18th Century. This is first painted all

over to represent quartered walnut, then the artist has gone further and copied on the four panels representations of elaborate inlays in metal and wood. It is very well done. To the purist it represents a triumph of misapplied skill, because the artist has used painting, not in its straightforward, legitimate way, but to imitate with great patience another technique. There is also an example of the imitation of ironwork by means of painting on a chest preserved in the sacristy of the great church in Zurich. The first impression of this chest suggests that its doors are treated with elaborate iron hinges, but a closer inspection reveals the fact that the metal consists of plain horizontal straps, and that the foliation and decorative work is painted in black on the surface of the wood. It became fashionable in Holland in the 18th Century to paint both fitments and moveable furniture with patterns in colour. Hindelopen, a village in the province of Friesland, was the chief centre of this kind of work.

Carving, particularly the free scroll work associated with the rococo period, was imitated all over Europe by those who painted woodwork. The painted furniture, most generally free from attempts to counterfeit other modes of enrichment, was that made by peasant craftsmen, who were content to express by means of free brushwork and bright colours the animal and floral forms with which they were familiar.

Furniture has at one period and another been regarded more or less as the background for the kind of painting which we associate with the easel picture. It was on some of our 18th Century work that Angelica Kauffman and others exercised their skill in the painting of pastoral scenes, or classical subjects, notably on the fine commodes and cabinets of the period.

There is in the Museum at Vienna a very elaborate cabinet covered with swags and bunches of flowers on a light ground, the painted detail having all the minuteness and sparkling colour which we associated with china painting. There has of late years been a revival in respect of painted furniture. It is not part of my business here to voice personal preferences and prejudices, but I believe that, through long association of ideas, we like our furniture not only to be made of wood, but to look as though it were made of wood. Our household furniture is made to be handled and used, and a painted surface with elaborate decoration does not stand the ultimate test of wear very well.

NEWFOUNDLAND.

TRADE, RESOURCES AND DEVELOPMENT.

The Report* on the Trade, Industries and Resources of Newfoundland for 1925, by H.M. Senior Trade Commissioner in Canada and Newfoundland, contains much useful information to those desirous of increasing their trade with that Colony. In his introductory remarks, Mr. Field points out that Newfoundland is the tenth largest island in the world, and is about one-third larger than Ireland. Its area is 42,734 square miles. Both Europe and the mainland of Canada and the United

* Published by H.M. Stationery Office, Price 2s. 3d. net.

States are within easy reach. The Colony is only 1,640 miles from the coast of Ireland as compared with a distance of 2,600 miles from Ireland to New York.

Visitors from the United Kingdom may make choice of a variety of routes. The fast Atlantic liners to New York, Boston, Halifax (N.S.), St. John (N.B.), Quebec or Montreal, make connections with United States or Canadian railways, which give an expeditious service to North Sydney (Nova Scotia), and link with the Newfoundland Government Railways, while the Furness-Withy Line maintains a direct service between Great Britain and Newfoundland by means of large and well-equipped steamers, which leave Liverpool about every fortnight for Halifax, calling at St. John's, Newfoundland. A business trip, to include Newfoundland, Canada, and the United States therefore may be arranged without difficulty. Newfoundland has as a dependency Labrador, the resident population of which is approximately 3,500 people, but every summer about 15,000 fisherfolk from Newfoundland go there to catch cod. The climate of Newfoundland resembles that of the Maritime Provinces of Canada. Winter seldom begins before the New Year, or lasts beyond the end of March. The thermometer rarely goes below zero during the winter months. The snowfall is heavy. In the summer, which resembles that of England, the temperature ranges from 70 to 80 degrees in the shade. Steamers ply to St. John's from Liverpool and New York all the year round. The census of 1921 places the population at 263,033. The City of St. John's, the capital, accounts for 36,370. Between Cape Race and Cape John about 140,000 of the total population are resident, 123,000 being scattered along the remaining coast line and inland. The greater part of the population live in the "outports," every place in the Colony, except St. John's, being included in that term. The second town of the Colony is Harbour Grace. Important new towns established in comparatively recent years, in connection with pulp and paper enterprises of United Kingdom interests, are Grand Falls and Cornerbrook.

Approximately 65,000 of the people are engaged in catching and curing fish. Fishing still is the Colony's principal industry. There are about 3,000 farmers and 35,000 fishermen, who also cultivate the land. Lumbering, mining, factories and workshops account for 6,000, and there are about 5,000 mechanics. The people are almost entirely of British stock. The more recent development of the island dates from the conclusion of what is familiarly known as the Reid Contract, which provided efficient operation of the Colony's railway and coast steamships, the establishment of a sawmill and a granite quarry, and numerous other enterprises. The iron ore mines at Belle Island have been another important factor in the development of the country, and, more recently, the establishment of two extensive pulp and paper industries, the control of both of which is within the British Empire.

The number of visitors to the island is increasing every year. The scenery is very attractive, and some of the best fishing and hunting are offered to sportsmen. Numerous tourists come from the United Kingdom and the United States every summer. Like many other parts of the empire, Newfoundland is suffering from the lack of sufficient personal contact with people of the United Kingdom. Holiday visitors from the British Isles will be welcomed. Responsible representatives of British firms doing business or desiring to establish trade connections in the Colony are asked to visit the country to acquire information at first hand. The visit in August, 1925, of a delegation of the Empire Parliamentary Association was one of mutual interest and value.

The recent erection of a new hotel at St. John's and the enterprise on the part of several steamship companies in increasing their services will, it is expected, attract larger numbers of visitors to Newfoundland. Efforts are being made by the Tourist

Bureau to ensure their proper reception and to make the country an attractive pleasure resort for tourists. The story of Newfoundland's trade in recent years is one which calls for attention on the part of British firms. the market is comparatively small, but the value of its import trade, $27,677,000 in 1923-24, is sufficiently large to justify efforts to increase the share of the United Kingdom. In 1919-20 the imports were valued at $40,533,000. In 1888 the United Kingdom had 44 per cent. of the import trade of Newfoundland, and in 1923-24 it secured only 22.5 per cent. The United Kingdom has come from the first position to occupy the third in the list of countries exporting to the Colony. Canadian exports occupy the first place at present, on the mean of the last three years. There is a marked desire on the part of Newfoundland merchants to increase the share of the business now obtained by the United Kingdom.

In view of the change which has occurred in the United Kingdom's position in the trade of Newfoundland—largely due to recent war-time events—Mr. Field's Report gives fairly detailed information and statistical data as to natural resources and trade which will enable United Kingdom manufacturers and merchants to analyse the position so far as their own trades are concerned.

The past few years have witnessed a steady maintenance of the fishing industry, the extension of agricultural pursuits, preliminary investigations of mineral resources and the establishment of important paper industries. In Mr. Field's opinion there is likely to be a gradual and healthy development in the island. Road-building is to be given more attention and a sum of $2,000,000 was appropriated in 1925 for that purpose.

KAURI GUM INDUSTRY OF NEW ZEALAND.

Kauri gum is fossilised in mineral form and dug from the earth at shallow depths where kauri forests were buried by volcanic action during comparatively recent geological periods. It is particularly a product of the Auckland district, New Zealand, and the industry is localised on the peninsula to the north of the city of Auckland.

Kauri gum is exported principally to the United States and the United Kingdom, where it is used in the manufacture of high-grade varnishes and linoleums. Imports into the United States decreased from 5,869,308 lbs. in 1924 to 4,634,495 lbs. in 1925. The decrease in demand has come chiefly from the United States, where it is claimed that kauri is being replaced by certain synthetic products.

Official figures for the actual amount of kauri gum coming from the gum fields indicate a total of 5,069 tons (of 2,240 lbs.) in 1925, as compared with 5,434 tons in 1924 and 6,502 in 1923.

From a recent report by the United States Consul at Auckland, it appears that kauri gum is yearly becoming more difficult to obtain with the exhaustion of surface supplies. The gum does not lie in veins or beds, but here and there in lots, and modern methods of mass earth removal apparently would not prove profitable.

During the past year the New Zealand Government passed the kauri gum control Act, providing for a Board to be set up, composed of representatives of the producers, the middlemen, and the Government, to have authority to monopolise the entire movement of kauri gum shipments. The idea is, of course, to valorize the kauri gum output for the benefit of the producer. It seems hardly possible, however, says the Consul, that this Board will be able to accomplish the ends for which it has been established, for, although kauri gum is only found in New Zealand, it competes with varnish gums from many other parts of the world, and thus the control of the New Zealand output would in itself not be sufficient to enable any Board to carry out a valorization policy.

The Government of New Zealand is preparing to open during the present year certain new gum fields known as the Peorta and the Kara, 10 to 15 miles from the port of Whangarei. The individuals taking up this land will receive certain support from the Government for the purpose of carrying on digging operations.

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FRIDAY, AUGUST 20th, 1926.

All communications for the Society should be addressed to the Secretary, John Street. Adelphi, W.C. (2.)

NOTICE.

FUND FOR PURCHASING THE SOCIETY'S HOUSE.

The following contributions to the Fund for Purchasing the Society's House have been received since the last list was published in the *Journal* of May 21st, 1926 :—

	£	s.	d.
Amount previously acknowledged	43,343	10	5
Sir Edward D. Stern, Bt., D.L.	25	0	0
Messrs. J. S. Fry & Sons, Ltd.	10	0	0
S. Rumson Curtis, Esq.	1	1	0
	£43,379	11	5

Fellows of the Society are reminded that the amount aimed at by the Council is £50,000, which, in addition to purchasing the freehold, will cover the cost of renovating and decorating the house.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE DECORATION OF FURNITURE.

By H. P. Shapland, A.R.I.B.A.,
Editor of the *Cabinetmaker.*

Lecture III.—*Delivered February 1st, 1926.*

Applied Metalwork.

One of the reasons why much of the furniture made to-day lacks the interest and character of that of earlier periods is because cabinet makers have learned how to hide its construction. Practically all modern cabinets, sideboards,

wardrobes and bookcases are fitted with doors, but the locks and hinges are kept out of sight, and by hiding them thus features which might be of decorative value are lost. There is an early cupboard preserved in the Victoria and Albert Museum, London, which illustrates the decorative effect obtainable by the use of the simplest form of metalwork. It is a plain oak piece and dates from the fourteenth century. Without the smith's work the cupboard lacks interest other than that which attaches to it historically, but with the addition of the iron hinges it becomes a piece of furniture of considerable decorative value. The doors are formed of wide boards which are not framed in any way. There is a theory that the metalwork served to prevent the warping which would inevitably take place, but experience would have taught the futility of this expedient. It is more probable that the smith who was commissioned to make the hinges wrought them out of sheer love of manipulating the ductile material, for, while the design in general gives an impression of balance, there is great freedom and liveliness in the details.

From blacksmith's work of the simplest and most direct kind wrought iron work of elaborate character was evolved. The nail heads were wrought as rosettes, the hinges and lock plates were not only treated with scrolls, but pierced, and the handles were very decorative. The enormous strength of the early iron-bound wooden chests suggests that they served as a safe does in modern times for the protection of valuables, and the fact that they were fitted with heavy and ingeniously contrived locks is further evidence of this. Sometimes the fronts and tops of chests were entirely covered with small scrolls in iron, and occasionally the metal mountings took the form of bands running parallel to one another, a decorative effect being obtained by the use of hundreds of rivets. In each case strength was evidently the main consideration. In the later chests, though the ironwork survived, there was no attempt to obtain impregnable security by its use. Instead of being strongly wrought and of considerable thickness, the metal became thinner and was beaten in order to give it a certain amount of relief. In the earlier chests the iron mounts did in effect support and strengthen the woodwork, while in the later ones the metalwork has the appearance of being applied to the surface of the wood, the tradition of the ironbound chest surviving when there was no longer such imperative need for strength. There can be no doubt that furniture makers fell in love with applied metal as a method of enriching their work. In particular, Spanish cabinets of the Renaissance were ornamented with pierced iron work, and this was no longer confined to the lockplate, hinges and escutcheons, but extended over the surface of the work as pure decoration. In many such instances the effect of the pierced metal was heightened by backing it with some coloured textile material.

During the florid period of French furniture—Louis Quatorze, Quinze, Seize and the Empire—wood was subordinate to the applied metalwork. Ormolu mounts tended little by little to cover and ornament the whole structure.

Although this furniture was French, England in all probability possesses examples as fine as France herself, as she profited more than any other part of the world by the sales of furniture which followed the Revolution, the noble families in their destitution being eager to dispose of such pieces as escaped the destructive activities of the mob. The bronze ornaments and mouldings of such pieces were generally gilded. In the Empire style they were flat gilt, a process which, it is believed, was discovered by Gouthière.

LACQUERING.

In spite of the zealous guarding of the secrets of the process of lacquering furniture as carried on in the Far East, definite information has reached Western Europe from three different sources which, in their main outlines, and in many of the details, corroborate each other. The best-known account, and the one most frequently quoted, is that of a corresponding member of the French Academy of Sciences, a Jesuit missionary named Father D'Incarville, who sent home his memoir from China about 1740. For the next detailed account of the process Europeans had to wait for more than a hundred years. Then, at the beginning of the year 1882, Mr. John J. Quin, a British Consul domiciled in Tokio, wrote an exhaustive paper on the subject; the original may be consulted in British consular reports. A year or two after this, Dr. J. J. Rein, a professor at Bonn University, was sent to Japan to study the industries of the country on behalf of the German Government, and the results of his investigations were published in 1889 in a book entitled "Industries of Japan," an English translation of which may be found in most important libraries.

I propose, having indicated the best sources of information, to give the briefest possible outline of the process. The raw material is obtained from lacquer trees; the sap, which is collected by tapping, is first of all exposed to the sun in shallow vessels in order to eliminate the water which exudes with it. The process of evaporation is hastened by the addition of a further small percentage of clean water and by stirring it from time to time. The raw material is of a cream colour. Before use it is treated with vermilion, black and other colours, and it is most carefully strained to eliminate dust and sediment as far as is humanly possible. The process consists of the application of many coats of lacquer, drying after each application in a damp press and rubbing down with various substances to obtain an absolutely smooth surface. Between the first application and the last rubbing down it is said that there are as many as thirty or thirty-five different processes, and this for ground work alone, before ornamenting in gold and colour. Each of the accounts mentioned above lays the greatest possible stress on the drying of the lacquer, which can only be effected in a damp atmosphere. D'Incarville, in his memoir, for instance, says, "At Peking, where the air is extremely dry, it is necessary, in order to dry the varnish, to put it in a humid press

surrounded by matting, which they sprinkle with fresh water. If it is an article which is so situated that it cannot be moved, they are obliged to hang wet cloths about it." Quin also states that the articles are set in damp presses. These are airtight and made of rough unplaned planks which are thoroughly wetted with water before the articles are put in to dry. Unless placed in a damp, closed atmosphere, the lacquer will not dry. This method of drying is undoubtedly a very important point, and one very little understood by European craftsmen. Varnishes, as we know them in Europe, are dried in a warm, dry room, while these Oriental lacquers are dried in a wet, cold atmosphere.

As far as chemical investigation has gone, the reason for this would appear to lie in the fact that the drying process does not consist in the evaporation of a solvent as with ordinary varnishes, but that it is due to chemical oxidation which occurs in the lacquer itself, hardening it in course of time. This oxidation is brought about by the action of a ferment of the kind known as an enzyme. The enzyme contained in lacquer requires a damp atmosphere in order to work to the best advantage, and it is through this curious chemical action that the lacquer becomes hard. It was surfaces such as these, built up with extraordinary care and skill, that the Chinese and Japanese artists then proceeded to decorate. Lacquer may be incised, carved, inlaid or painted, and there is no method of enriching furniture in which such splendid decorative effects can be obtained. In surface texture, colour and ornament, a fine piece of lacquer is an incomparable achievement of craftsmanship. During the many recurring periods when furniture in the Chinese manner has been fashionable, European craftsmen have endeavoured to imitate the lacquer work of the East, but as the Western craftsmen lacked both definite knowledge and inherited skill, the lacquer work which they have done, although some of it was quite admirable, is wanting in the vigour and spirit of the Oriental pieces. It is really a kind of glorified coach painting. It is evident that the decorators are working in a technique with which they are not fully acquainted, and it is obvious when the Eastern and Western work is compared side by side that the Japanese or Chinese painter has an unconscious deftness and unerring precision, whereas the Westerner is feeling his way in an unaccustomed medium. Much European lacquer was the work of amateurs, dating from the time when painting and japanning of furniture was a fashionable accomplishment of young ladies, and it is probable that Chinese and Japanese artists, steeped in the tradition of their craft, would hold that the greatest part of the lacquer furniture, which is made commercially in Western Europe at the present time, was very amateurish. Much of it is mere painting, and possesses none of the true quality of Oriental work.

Applied Textiles.

Luxurious upholstered furniture, in which there are complicated arrangements of springs, horse-hair stuffing and down cushions, is a comparatively recent

introduction, and every well-furnished dwelling at the present time contains numerous examples of upholstered work entirely covered with textiles. But prior to the general use of this kind of upholstered work, which is one of the great contributions of the late nineteenth and early twentieth centuries to the history of furniture, there were periods when textiles or leather were used in a purely decorative manner. Chests and coffers were entirely covered with leather, needlework or rich materials, such as velvet. In the case of leather, when the material was plain, an ornamental effect was obtained by the decorative use of thousands of nail heads by means of which the material was applied to the wood. In other cases the leather itself was elaborately tooled, subjected to a hardening process, and applied to the surface of the work. Embroiderers were responsible for gros-point and petit-point panels used for the covering of small boxes, coffers, screens and chairs. Very beautiful petit-point panels were also used to ornament the pole-screens of the eighteenth century in England. There is a large piece of work covered with embroidery preserved in the Victoria and Albert Museum, which is probably of Dutch manufacture. In the seventeenth and eighteenth centuries leather-covered screens became fashionable, painted in a variety of ways with figure subjects, or, in the eighteenth century, with Chinese motifs evidently inspired by screens of Oriental lacquer. Panels of needlework actually framed up in furniture are comparatively rare but not unknown: there is in the Victoria and Albert Museum a late eighteenth century cabinet in green lacquer, the inside of which is decorated with panels of embroidery. The most notable examples of furniture in which the decorative effect is obtained by covering the surface with textiles are the great beds of the seventeenth and early eighteenth centuries, which were entirely covered with textiles, even to the mouldings and carved detail. There are many such beds preserved in the State Apartments at Hampton Court.

The material selected for covering furniture in this way was generally a velvet with a fine, brilliant pile, somewhat similar in appearance to modern velveteen, although other fabrics were used, such as brocades, damask and fustian. Plain velvet was the most popular, and owing to the difficulty of covering complicated angles of the mouldings and ornaments it was necessary to cut this material on the cross to obtain a clean, even surface, free from wrinkles or fullness. To many of these old beds the textile still adheres with great tenacity, and this has given rise to the belief that some specially prepared solution, or some secret process which has been lost sight of, was employed, but it is more probable that the adhesive was nothing more extraordinary than good flour paste, which is the preparation used to-day by upholsterers when lining cabinets with silk or other material. The method of applying the paste was as follows:—The moulding or projection was covered with a plentiful supply of paste, on this a layer of fine tissue would be fixed; after this a second layer of paste would be given, and on this the covering material

would be laid. In the case of heavy fabrics the paste was applied to both the wood and the material without the insertion of the tissue. The covering of mouldings and carved ornaments necessitated very skilful workmanship, and great pains were taken to avoid the creation of any fullness in the material. The cutting of the material on the cross would to some extent obviate the danger of wrinkles on convex surfaces, and is one of the reasons why plain velvets were more in favour than figured ones. The adhesive properties of paste made of good fine flour and water are well-known, and old recipes for such paste state that the flour should never be used new and should be well kneaded.

During the fine period of French furniture manufacture Beauvais and Aubusson tapestry was specially woven for the seats and backs of chairs and settees, and in these the tapestry constitutes in a very real sense the decoration of the pieces.

There are other methods of decoration which should be mentioned briefly in conclusion. Occasionally we find carved chairs and cabinets completely overlaid with ivory: such furniture, if made in Europe, is generally covered with ivory in India by men who are experts in that kind of work. Tortoiseshell is also used generally in mirror frames, but occasionally covering the entire front of a cabinet or a chest of drawers; when backed with colour, notably vermilion, a very brilliant effect is obtained. Perhaps the most famous piece of ivory-covered furniture in this country is an elaborate cabinet at Ham House, the property of the Earl of Dysart: it is of Dutch manufacture. The ivory is first worked into the waved moulding described in the first lecture. The cabinet is illustrated in Mr. Percy Wells' book on cabinet making. Another type of decoration is met with on chests, which I have found mostly in the West of England, where they are called Cypress chests. The fronts are incised with very elaborate patterns, and into the incised lines a mastic of some dark colour is rubbed. I am told by sailor men in the West of England that they were brought from the Mediterranean filled with silks. There is little doubt that they are of Italian origin.

Gesso Work.

Gesso work is a decoration stamped or modelled in relief on the surface of wood coated with plaster and hardened in various ways to make it capable of standing the wear to which furniture is subjected, this raised decoration being subsequently painted or gilded. Gesso was used freely in mediæval times. The Adam Brothers carried the idea a little further when they introduced a composition ornament made in moulds; this they specified for their ceilings and mantelpieces. This composition is a material which is plastic when heated, in which state it is applied to the surface of the wood; when cool it becomes very hard. It is an inexpensive form of relief decoration.

In museums and palaces all over Europe there are to be found cabinets of a most elaborate kind which take the outlines of palaces and temples: in these woodworkers, brassfounders, jewellers and goldsmiths have combined in producing miniature reproductions of the façades of Renaissance buildings. A typical example is a cabinet of pear wood with the front completely rusticated, having little columns of lapis lazuli with gilded capitals and bases, niches filled with tiny statuettes, either of gold or silver or occasionally of rock crystal. These pieces de luxe, where the aim has been to crowd as many precious materials as possible together in the smallest possible space, can hardly be considered as furniture in the ordinary sense of the word. Furniture in such cases is merely an excuse for the exercise of fine workmanship and ostentatious display. Cabinet work has also been decorated by using painted panels of Sèvres porcelain, Wedgwood plaques modelled by Flaxman, coloured marbles, and by the use of Pietra Dura, which is an inlay of hard pebbles, agate, lapis-lazuli and other stones.

Those who are engaged in the designing and making of furniture have all these methods and materials at their disposal for the decoration of furniture, and while it seems desirable that they should be thoroughly conversant with what has been done in the past, for present-day practice a word of caution is perhaps necessary. It has become easy owing to the development of machinery to produce infinitely more ornament than heretofore. It is possible to carve, weave, print, press, bend, stamp, fret and mould ornament economically and literally by the mile, and what we are suffering from at this moment is a riot of ornamentation on the various materials which make up the furnishing of our homes—ornament following no definite tradition and derived from half a hundred different sources quite unrelated to each other. It is at present possible for a person of quite moderate means to have his walls, carpet, ceiling, mantelpiece, table cloth, curtains and chairs literally smothered with ornament, and this before one considers at all the hundred-and-one things which find their way into a room—secondary things which become necessities. These include pictures, prints, newspapers, books, pottery, flowers, electric light fittings and so forth. If there were some sense of style in all this it would not be so disturbing. For example, in an elaborate room designed by Robert Adam, there was a sense of unity, but to-day, with this wealth of material provided for us, you may have an Adam ceiling, a William Morris wallpaper, Indian rugs, an elaborate linoleum of parquet pattern, cretonne coverings of a Portuguese design, Persian tiles in the grate and Louis Seize electric light shades, in a word, a crowd of things totally unrelated to each other. Therefore, in furniture at present it is necessary to plead for reticence in this matter of decoration. Life, with its railways and telegraphs, its newspapers and receiving sets, its motor cars and divorce courts, becomes increasingly complex, and in modern furnishing the wise ones are providing themselves with a contrast. Quiet surroundings and

useful pleasant things which look as if someone had taken a little thought and pride in making them for the service and pleasure of his fellow creatures, and not turned them out by the mile fully ornamented. We need first to learn the value of reticence, and then I have no doubt we shall begin to take a fresh interest in fine decorative work.

OBITUARY.

Lieut.-Col. His Highness the Maharaja of Dhar, K.C.S.I., K.C.V.O., K.B.E.—H.H. the Maharaja of Dhar, who died at Solon, near Simla, on July 30th, was a life fellow of the Society. For nineteen years, since he received the reins of power on reaching his majority, he exercised an enlightened rule over the State of Dhar in Central India, possessing an area of nearly 1,800 square miles and a population of about a quarter of a million. During the late war he made notable contributions, including motor ambulances, mules and horses, as well as much personal effort, to the Imperial resources. A great lover of horses, he was never happier than when breaking in a vicious animal or handling the ribbons on the box-seat of a coach. He was the author of several books on horses and shooting, including one on the training of vicious horses.

The late Maharaja possessed all the attributes of a country gentleman of the old school, and will be much regretted by his many English friends, as well as by his Indian subjects.

CORRESPONDENCE.

FINSBURY TECHNICAL COLLEGE.

A correspondent writes :—" The statement on p. 885 of the *Journal* is not quite accurate. The Foundation Stone was laid by the late Duke of Albany in the year 1881, and in the speech he made on that occasion he described the College as ' the first Technical College erected in London.' The Inauguration ceremony, at which the college was formally declared open, took place on February 19th 1883."

ATMOSPHERIC POLLUTION.

In his annual report on the public health of the City of Birmingham, Sir John Robertson, C.M.G., the Medical Officer, deals at length with the smoke nuisance and its effects. The extent, he says, to which the products of combustion are in the air of any large city has three chief influences on the inhabitants of the district—" it is prejudicial to health, it causes a great deal of unnecessary labour and cleansing and it limits the growth of many plants, and, therefore, hinders what is beautiful or useful in town gardens."

By far the most important of these, he considers, is the fact that all smoke or dust in the air shuts out, in direct proportion to its amount, the ultra-violet rays and prevents them from reaching the dwellers in the area. The absence of these rays for the greater part of the day lowers vitality, and by so doing renders most people susceptible to ailments which they themselves would not associate with the absence of sunlight.

"This deleterious effect," the report goes on, "is for the most part produced by the very light and minute particles of soot which are carried high up in the air, and form by their presence an effective barrier to the sun's rays. It is possible to demonstrate this even when with unaided eyes the sun looks clear over the City."

Sir John Robertson then quotes Professor Cohen, of Leeds, who found, as a result of a long series of experiments, that "approximately 6 per cent. of the carbon consumed in a factory or domestic fire is passed up the chimney in the form of soot. In addition to soot there is a very definite amount of tar derived from coal combustion. This tar coats our windows, and causes the soot and dust to adhere to them."

A certain amount of sulphurous acid, he observes, is also thrown into the air from the combustion of coal. This sulphurous acid is soon converted into sulphuric acid, which causes considerable damage to metal and stoneware articles by producing chemical changes, rusting and decay, and has also a very deleterious effect on vegetation. In the central areas of a town the acid commonly kills the plants in course of time.

Many calculations have been made of the extra cost of washing and cleaning in a town cottage, compared with that of a country cottage. Every town dweller, however, is familiar with the difference which exists between the cleanliness of town and country.

"The remedy," says Sir John, "lies in getting rid of the use of soft coal for open domestic fires, and the more careful and economical use of such coal for commercial purposes. For the present the abolition of the use of soft coal in open domestic fires is a remedy which would be generally regarded with disfavour. But it is one which is not so unreasonable as would at first sight appear, because there is nothing on which we spend money so uneconomically and wastefully as on heating a dwelling room by means of an open fire. Probably, from 90 to 95 per cent. of the cost is wasted."

Pending the time when the public will demand the abolition of the open coal fire, Sir John points out that great strides can be made in the heating of dwelling houses by the use of hot-water pipes, gas, electricity, or smokeless solid fuels of one kind or another. In the case of commercial processes much can be done by the substitution of electricity or gas for power purposes, and for metallurgical and many other processes requiring heat.

He ends with an exhortation. It must be the duty of everybody to limit the amount of smoke from his dwelling house. Cooking by gas has become almost universal in cities; while gas fires are being constantly improved. All this bears out what the Coal Commissioners stressed in their Report—that the pollution of the air by coal smoke is a very serious problem, yet one which can be largely solved by consuming in a less wasteful manner the 147 million tons of coal at present burned in a raw state every year. If much of this coal were carbonised and used in the form of gas and coke, a real economy, as the Commissioners suggest, would result and purity of air be achieved as an enormous incidental gain.

NATURAL RESOURCES OF COSTA RICA AND PANAMA.

Costa Rica.—In his Report for 1925, on the trade and commerce of Costa Rica, H.M. Consul at San José points out that with a fertile soil and the great range of temperature from tropical coast line to 11,500 feet, where white frosts are frequent at night, Costa Rica can produce almost anything, but owing to lack of roads and other means of communication, a great part of the country is still uncultivated.

In the temperate regions, coffee, sugar, cane, maize, beans and upland rice are cultivated, and in the higher parts, there is a considerable amount of dairy farming.

The only mineral worked is gold, on the Pacific Slope. No mineral survey has ever been made, but copper, iron, manganese and sulphur are known to exist in very considerable quantities.

Panama.—Reporting on the natural resources of Panama, the British Vice-consul at Colon writes that the cultivation of bananas is rapidly extending on the Atlantic coast, as well as on the shores of Lake Gatun, and development is likely to increase for some years. Until comparatively recent times, cocoanuts held prime place among the products of the Republic, since these are essentially a littoral crop, and plantations could in consequence be easily visited from the sea, whereas crops grown inland could in general be transported to distributing centres only by laborious journeys along jungle tracks. Now, however, the development of roads and of water transport is removing the main difficulty of the planter, and large tracts of land in the interior are being devoted to bananas, a crop which gives a speedy return and for which there is an ever-growing demand. Until the end of 1922, there was little organized production outside the plantations of one company in the Province of Bocas del Toro, and in that year the shipments from the port of Cristobal totalled 206,688 bunches. Now, new companies are rapidly acquiring and developing suitable land, and at the present date banana shipments average little less than 200,000 bunches a month.

Cocoanut cultivation was enormously stimulated during the war, when the price rose at times to the extravagantly high figure of $100 a thousand nuts. Since then, the demand has greatly fallen, and, although exports continue to rise, very little new land is being devoted to cocoanuts, for the crop is one which gives slow returns, trees coming into full bearing only after about eight years.

Sugar-cane, like the banana, is a crop giving a speedy return. In limited areas, such as Bugoba in the Province of Chiriqui, cane can be cut twice or even thrice a year, and even in less-favoured districts, where the soil has not the same exceptional fertility, a crop is taken every nine months. There is at present no exportation of sugar, nor is there any near prospect of exports becoming possible. All the sugar that can as yet be produced is consumed in the Republic, and importation continues to be necessary to cope with the local demand.

Although the climate is suitable to cacao growing, and favourable soil is easily found, comparatively little acreage is at present devoted to this crop. One company has a plantation of over 200,000 trees at Chiriqui Grande, but no other large-scale grower is in the field. Numerous small independent producers, however, are able to show an increasing production, and that prospects for cacao are favourable is indicated by the fact that the company referred to above has cleared and planted further acreage for this crop.

Wild balata has suffered in recent years from excessive tapping, and production is in consequence declining. Rubber plantations do not as yet exist in the Republic, but, in view of the heavy demand for rubber in the United States, it is possible that planting may be attempted. Local opinion does not view such a possibility with any great hope of success.

Excellent coffee is grown in the more mountainous districts, where soil and climate are most suitable, but production has not yet risen to a point at which imports would become unnecessary.

A small quantity of cotton is grown, but no systematic cultivation on a considerable scale has yet been attempted. A fairly good staple can be produced even in present conditions. A law has been passed the purpose of which is to encourage

the cultivation of cotton by all possible and practicable means. To this end, the engagement is authorized of experts, from countries similar in climate and in language to Panama, who shall determine the districts in which cotton should be cultivated. For the first year, experimental growing is to be confined to districts in not more than two provinces. Quarterly returns by the experts are to be distributed, explaining the process of cultivation from the beginning. As a stimulus to intending cotton-growers, loans are offered by the National Treasury of $100 per hectare. Temporary ownership of 10 hectares of land is also offered, on condition that the land must be put under cotton cultivation within one year.

There is excellent soil for tobacco throughout the Republic, and an effort is at present being made to extend the cultivation of this crop. For this purpose, a governmental school has been established, at which methods of cultivation are taught.

INDUSTRIAL DEVELOPMENT IN ARGENTINA.

Argentina is still primarily an agricultural and pastoral country, but, according to information furnished to his Government by the United States Consul-General at Buenos Ayres, the increasing volume and variety of local industry has made itself sufficient in certain fields. In 1925 several new industries sprang into being, and there was a notable increase in the activity of others.

It is estimated that approximately 90 per cent. of the furniture used in Argentina is manufactured locally. An important branch of this industry is the making of cabinets for phonographs and radio sets, the motors and parts being imported. The making of automobile and truck bodies, and automobile accessories, have had a considerable development in recent years.

The manufacture of windmills has assumed large proportions since 1924, and at present there are six concerns engaged in this industry. Windmills are used extensively in Argentina, principally on the Atlantic coastal plains and pampas, where the flat surface of the land makes gravity flow virtually impossible. Ploughs are also manufactured in Argentina.

The Government commenced the manufacture of sulphuric acid during the past year and three large plants are now in operation. It is estimated that 10 per cent. of the patent medicines, drugs, and toilet preparations used in Argentina are now made in the country. The manufacture of paints with domestic linseed oil has developed greatly within the last six years. Considerable quantities of borax and soap are manufactured locally for domestic consumption. The greater part of the cement used in Argentina is supplied by local manufacturers ; this industry is a new one and of some importance.

Argentine-made shoes have largely supplanted the imported varieties. The textile industry has increased its output during the past two years and domestic shirts, collars, and underwear are now entering into competition with American and English makes in the home market.

The packing-house industry is of considerable importance, the slaughter for last year reaching a total of over 3,300,000 head of cattle and sheep.

Another important industry in Argentina, the production of quebracho extract and the marketing of quebracho logs, showed a notable improvement in 1925 over the previous year.

The future of manufacturing in Argentina depends largely on the supply of raw materials and fuel. The national reserves of iron and coal are limited. There are, however, large petroleum reserves ; the national production of crude petroleum

increased from 4,000,000 barrels in 1924 to about 6,000,000 barrels in 1925, the importation of crude oil having fallen to half its former volume as a result of the increased local production. The installation of a Government refining and cracking plant at La Plata is expected to do much in the matter of securing cheaper fuel for manufacturing industries. Manufacturing associations were active throughout 1925, and the display of domestic goods at the National Industrial Exhibition held in the Federal Capital during the first three months of 1925 did much to stimulate interest in manufacturing.

FRENCH DYESTUFFS INDUSTRY.

The production of coal-tar dyes has made immense progress in France, which is now able not only to procure within her territory the bulk of her requirements, but also to undertake a considerable export trade. French release from undue dependence on foreign suppliers is shown by the recent figures of production and of imports: in the four years 1920-23 the annual output of French factories amounted respectively to 7,056, 5,869, 8,067 and 10,000 tons, and the annual imports to 5,888, 1,148, 1,797 and 1,371 tons. Imports, therefore, which represented 83 per cent. of the home output in 1920, had sunk to only about 22 and 14 per cent. in 1922 and 1923. As it is stated that the 2,500 tons produced by the Swiss factory at St. Pons are not included in the 1923 figure of French output, the imports really represented about 9 per cent. of the dyestuffs production on French soil in that year. As regards the separate categories of dyes, imports of azoics have decreased from nearly half the amount of the home output in 1920 to about 16 to 8 per cent. in 1922 and 1923, when 3,575 and 5,124 tons were produced and only 906 and 444 tons were imported. The indigo dyes made in France (2,649, 1,395 and 2,132 tons in 1921-23) seem ample for the home demand, so that imports have practically ceased (51, 12 and 4 tons in 1921-23); and production in the sulphur group in these three years was 823, 1,710 and 2,279 tons as against imports of 47, 78 and 58 tons. Similar independence appears to have been practically secured as regards other groups such as alizarines, oxanines, thiazines, etc.; in fact, over 600 dyes covered by nearly 1,000 registered patents are now made in France.

This rapid progress in quantity, quality and range has been brought about, states the Commercial Counsellor to H.M. Embassy at Paris in his annual Report, by the determination to achieve self-sufficiency in a key industry, which led to the formation during the war of a strong national company, to the redoubled efforts of other producers, to the protection of the State, and not least to the fact that patent rights, processes and technical skill had been acquired from foreign competitors, which had resulted in a considerable saving of time, as advantage was gained of fifty years' experience of the most specialised modern firms in the industry. The agreement, which was reported in 1922 to have been made by principal French producers with German producers is said to have stipulated that German makers were to place their laboratories at the disposal of certain French makers; and that certain limitations as to the marketing of products were to be reciprocally respected. No authoritative public statement appears, however, to have ever been made concerning this alleged agreement, which is now reported in any case to have become inoperative since about the end of 1922. At the present time, so far as France is concerned, she possesses in many branches a productive capacity in excess of home consumption (although as yet unable to produce the entire range, including vat dyes), and requires considerable foreign markets.

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FRIDAY, AUGUST 27th, 1926.

All communications for the Society should be addressed to the Secretary, John Street. Adelphi, W.C. (2.)

REPORT ON THE COMPETITION OF INDUSTRIAL DESIGNS, 1926.

INTRODUCTION.

The annual competition of Industrial Designs was held for the third time this year, and it is satisfactory to note that on the whole the judges consider that the standard of excellence is very decidedly higher than on the two former occasions. In 1924, when it was held for the first time, the judges were disappointed in the quality of much of the work submitted, though there were a certain number of good designs which encouraged them to hope for better results in future. Last year, although in one or two sections the work was still poor, in others there was a distinct advance. In the Textile Section, for instance, the judges decided to award a Travelling Scholarship of £150, and a similar Scholarship was granted in the Architectural Decoration Section. Both these scholars have now spent several months on the Continent, and they have certainly derived great advantage from the opportunities of extended study which have thus been provided for them.

In addition to these scholarships a sum of about £1,700 has now been distributed as prizes during the last three years.* The Council have received assurances from many quarters that the Competition has aroused the greatest interest among the students generally, and in some schools they are informed the work is being carried on with a zeal and earnestness which have never been known before.

For the benefit of those whose work is approved by the judges for exhibition, it has been decided to start a Bureau of Information where their names will be enrolled if they desire to obtain employment as designers. The information will be placed at the disposal of manufacturers, and it is hoped that the Bureau will be of service both to manufacturers and designers.

* This money has been provided by the generosity of those whose names are printed as an Appendix to this Report. All the money subscribed to the Prize and Scholarship Fund has been devoted to prizes and scholarships, without any deduction being made for the expenses of the competition.

A larger number of firms than hitherto have this year offered special prizes for particular subjects. Some of these, *e.g.*, Messrs. Lever Brothers' prize for advertising " layouts," and Messrs. Rowntree and Co.'s prize for a window display piece, are interesting as introducing new lines of work. Unfortunately, in both these competitions the designs submitted were not very satisfactory, but this is, no doubt, due to the fact that very few young designers have turned their attention to these subjects. The Council feel sure, however, that many will welcome the prospect of new fields being opened up for their talents, and they hope that more firms will come forward to encourage fresh ideas.

Thanks to the kind assistance of the Director, Lieut.-General Sir William T. Furse, K.C.B., D.S.O., the Society received permission to judge the designs and afterwards to hold an exhibition of selected specimens from July 31st to August 31st in the Upper East Gallery of the Imperial Institute.

Particulars of the Competition, 1926.

Particulars of the 1926 Competition were widely circulated at the end of 1925. The announcement of the subjects and prizes was as follows:—

Annual Competition of Industrial Designs.

The third Annual Competition of Industrial Designs will take place in June, 1926. It will be open to two classes—(*a*) All British Subjects (with certain specified limitations as to age in the Section of Architectural Decoration, Sub-Section (4), and in the Furniture Section), and (*b*) British Students in British Schools of Art.

Entries can only be received from individual designers, not from firms.

The subjects of competition will be the same for both classes of candidates, but in considering the work the Judges will bear in mind to which class the competitors belong.

The Competition will be divided under the following heads:—

(1) Architectural Decoration.
(2) Textiles.
(3) Furniture.
(4) Book Production.
(5) Pottery and Glass.
(6) Miscellaneous.

Particulars of the subjects prescribed in each Section, together with the prizes offered in connexion therewith, will be found below. The Council reserve the right of withholding any or all of the prizes offered, or of awarding prizes of less value.

The plans and particulars required by competitors in certain of the Sub-Sections (*see below*) are now ready, and can be obtained on application to the Secretary, Royal Society of Arts.

The Judges will be appointed by the Council of the Royal Society of Arts on the recommendation of the various Sectional Committees. *In making the awards, it shall be an essential condition that the designs approved are suitable for the materials for which they are intended.*

Designs for which prizes are not awarded may be " Highly Commended " or " Commended " at the discretion of the Judges.

The Society will confer its Diploma on any candidate whose work shows exceptional artistic ability and practical knowledge of the materials and processes of his trade.

After the awards have been made, a number of selected designs will be exhibited in London, and subsequently at suitable centres in the Provinces, where they will be brought to the notice of manufacturers likely to be specially interested in them.

The following are the subjects of competition in the various sections in 1926 :—

SECTION I.—ARCHITECTURAL DECORATION.

SUB-SECTION (1). *Metal and Glass Front for Lifts.* SUBJECT.—Ornamental Metal and Glass Front to Passenger Lifts in an important store building.

PARTICULARS.—There is to be a group of three lifts extending from basement to sixth floor. The design is to show the lifts at ground floor level approached from an enclosed lobby. The competitor is not required to show the treatment other than the one side, and the only openings to be provided are the three entrances to the lifts. The metal and glass treatment is to be within the line shown on the plan ; details as to indicators must be considered, and all the latest modern improvements provided. The construction of the lift within the metal enclosure need not be shown, except the positions of the guides and balance weights.

MATERIALS.—Materials to be used are left to the competitors, but a refined treatment is desired.

DRAWINGS REQUIRED.—Plan, elevation to 1-in. scale, with ¼ full-size detail showing metal construction, and a portion of design, full size, not exceeding 24ins. square.

NOTE.—The Committee do not desire, except on the detail drawing, that the competitor should do more than is necessary to illustrate the treatment.

Repeats in design may be stated, but not necessarily drawn. The Committee are desirous of reducing the amount of work in preparing the drawings, but will attach importance to the competitor's rough sketches in arriving at his final conception. These should be forwarded with the drawing.

They desire to give the competitor the utmost licence in design and have purposely not given dimensions for openings, except those determined by structural necessities.

PRIZES OFFERED : Messrs. Henry Hope and Sons offer a First Prize of £50, and Messrs. J. W. Singer and Sons, Ltd., offer a Second Prize of £25, for this subject.

Candidates entering in this Sub-section should apply for a drawing, showing the opening to be filled by the lifts, to the Secretary, Royal Society of Arts.

SUB-SECTION (2.) *Metal Shop Front.* SUBJECT.—Metal Shop Front, with entrance adjoining, in an important shopping thoroughfare.

PARTICULARS.—The shop front is to be designed within the dimensions given in the plan, and to be for a high-class shoe shop.

The entrance doors are to be in metal, and recessed. Provision is to be made for a Boswick Gate for enclosing the porch at night. There will be a plain marble enclosing architrave and stone pier and arch to door opening. The sides of the entrance porch may be used for showing goods at the discretion of the competitor. The window enclosure must be shown, and provision arranged for sun-blinds and special lighting. The question of heating, ventilation and condensation forming on the inside of the glass must be considered, and adequate access provided to the windows from the shop interior.

MATERIALS.—The materials to be used are left to the competitor, but a refined treatment is desired. No facia board is required, but the name of the shop may be worked in the design.

DRAWINGS REQUIRED.—Plan, elevation and sections to 1in. scale, with ¼ full-sized detail showing metal construction, and a portion of design, full size, not exceeding 24ins. square.

NOTE.—The Committee do not desire, except on the detail drawing, that the competitor should do more than is necessary to illustrate the treatment.

Repeats in design may be stated, but not necessarily drawn. The Committee are desirous of reducing the amount of work in preparing the drawings, but will attach importance to the competitor's rough sketches in arriving at his final conception. These should be forwarded with the drawing.

They desire to give the competitor the utmost license in design, and have purposely not given dimensions for openings except those determined by structural necessities.

PRIZES OFFERED: Messrs. Baguès, Ltd., offer a First Prize of £50, and Messrs. Chas. Smith, Sons and Co. offer a Second Prize of £25 for this subject.

Candidates in this Sub-section should apply for a plan, showing the dimensions given, to the Secretary, Royal Society of Arts.

SUB-SECTION (3.) *Metal Window Frames.* A design is required for the treatment of Windows to fill an opening 32ft. high by 10ft. wide, extending over the first, second and third floors of typical business premises (not a factory) in any commercial centre.

The facing of the building is in stone, and the thickness of the stone reveal is 1ft. 6ins. The position of the floor levels are indicated on a diagram, copies of which can be obtained on application to the Secretary, Royal Society of Arts.

It should be noted that the treatment of the ground floor windows is not included.

The design, which may be either straight, bay, or curved on plan, is to be executed in either rolled steel or extruded bronze sections, but enrichments in the form of cast iron or cast bronze may be added.

No balconies are to be included.

Sub-divisions by means of glazing bars should be considered, as well as a specification of the glass to be used.

The manner of ventilating and methods of cleaning the exterior must be specified.

The design, which is to embody exterior and interior treatment (both in metal), should be drawn to 1in. scale and full-size sections, showing fixing details and general construction, should be shown finished.

An indication of the colour treatment should be given in the case of steel by means of paint, and in the case of bronze by the application of vitreous enamels or various coloured non-corrosive materials.

PRIZE OFFERED: The Crittall Manufacturing Company, Ltd., offer a Prize of 50 guineas for this subject.

SUB-SECTION (4.) *Lewis Berger Scholarship.* The Lewis Berger Scholarship, of the value of £60 to cover the cost of fees, maintenance, materials and travelling expenses, is offered for competition annually. It is tenable at the Royal College of Art, London, for a period of three months for the purpose of study in Decoration and Decorative Painting. The holder of the Scholarship must be a *bona fide* apprentice, student or craftsman, either engaged in or preparing to follow the craft of painting and decorating. He must be not less than 18 or more than 25 years of age on the 1st May in the year in which the examination takes place.

Full particulars of the Scholarship can be obtained from the Secretary, Royal Society of Arts, on application through the Headmaster of any School of Art.

SUB-SECTION (5.) *Wallpaper.* The subject of competition is as follows :—

A design for a Wallpaper suitable for use in a Lady's Boudoir.

PRIZE OFFERED : A prize of £10 10s. is offered for this subject.

SECTION II.—TEXTILES.

The subjects of competition are designs for the following :—

Sub-section (1) Floor Coverings, including Carpets and Rugs, Linoleum and Floor Cloths.

,, (2) Woven Fabrics for Furniture and Decoration, including Tapestries, Damasks, Brocades, Figured Velvets, Table Damasks, and Moquettes.

,, (3) Printed Fabrics for Furniture and Decoration.

,, (4) Printed and Woven Fabrics for Dress, including Brocades, Fancy Dress Fabrics, Handkerchiefs, Tie Silks, Mufflers, Ribbons and other narrow goods.

,, (5) Machine-made Lace, Lace Curtains and Embroidery.

,, (6) Miscellaneous, including Hand-made Lace, Embroidery, and Open Work, Bedspreads, Cushion Squares, Tea Cosies, Batiks, etc.

Candidates may submit designs for any or all of the items in any or all of the foregoing sub-sections.

PRIZES OFFERED :

1. Travelling Scholarships.—The contributions to the Prize Fund are sufficient to allow the award of one, or possibly more, Travelling Scholarships to candidates of outstanding ability. [In 1925 a Travelling Scholarship of £150 was awarded.] The course of study to be followed by the successful candidates will be decided after consultation between them and the Judges.
2. Money Prizes.—The Judges are empowered to award, at their discretion, Money Prizes up to the value of £10 10*s*. each for designs for each of the articles enumerated above.

SECTION III.—FURNITURE.

The subjects of competition are designs for the following :—

Sub-section (1) The complete Furniture of a Reception Room (30ft. by 20ft.), following British Tradition.

,, (2) The complete Furniture of a Bedroom, following British Tradition.

,, (3) The complete Furniture of a Hall Lounge.

,, (4) The complete Furniture of a Living Room suitable for a House in a Housing Scheme.

,, (5) The complete Furniture of a Board Room.

,, (6) A piece of Furniture which can be used as a Sideboard in a medium-sized modern room.

PRIZES OFFERED: A prize of £20 is offered for the best set of designs in each of the sub-sections (1)-(5) inclusive, and a prize of £10 10s. for the best design in Sub-section (6). Second prizes may be awarded at the discretion of the Judges. No candidate may receive more than two First Prizes.

Candidates competing for subjects (1) and (2) may be of any age. Candidates competing for subjects (3)-(6) inclusive must not be over 25 years of age.

SECTION IV.—BOOK PRODUCTION.

The subjects of competition are designs for the following:—

Sub-section (1) *Either* or *both* of the following:—(*a*) Title Page entirely set from type, with or without Printers' ornaments; (*b*) a Title Page partly decorated. The Title Pages to be taken from any or all of the following:—

(*a*) "Sketches by Boz." Published by Chapman & Hall, London. (Size, Demy Quarto.)

(*b*) "The Pilgrim's Progress," by John Bunyan. Published by Grant Richards. (*The World's Classics.*) (Size, Crown Quarto.)

(*c*) Journal of the Royal Society of Arts. (Size, Demy Octavo.)

The copy in each case will be supplied by the Royal Society of Arts.

,, (2) Three Pages of Text, with Chapter Heading, from any or all of the works enumerated in Section 1 above, and in the sizes respectively indicated there.

The copy for (*c*) will be supplied by the Royal Society of Arts.

,, (3) *Either* (*a*) A Line Illustration, or (*b*) A Colour Illustration. (The subject of the design must be taken from a well-known book, *e.g.*, one included in the *World's Classics* or *Everyman's Library*.)

The design may be drawn to any size, but must be suitable for illustrating a Crown Quarto page.

,, (4) A Certificate in connexion with the Royal Society of Arts Examinations.

(The copy will be supplied by the Royal Society of Arts.)

,, (5) A Binding for "The Pilgrim's Progress," by John Bunyan, in *either* Cloth (blocked), or Leather (tooled).

All designs must be submitted on Paper, and not as finished articles.

PRIZES OFFERED: A Prize of £10 10s. is offered for each of the subjects set forth above.

SECTION V.—POTTERY AND GLASS.

The subjects of competition are designs for the following:—

China.

Sub-section (1) A Cup and Saucer, Cream and Bread and Butter Plate, with decoration suitable for enamelling.

,, (2) A simple decoration on a cup shaped as in a sketch which will be supplied to candidates on application to the Secretary of the Royal Society of Arts.

Earthenware.

„ (3) A Dinner Plate and Vegetable Dish, with suitable decoration.

Glass.

„ (4) A Service of Glass (*i.e.*, a Wine Glass, a Tumbler and a Decanter) in plain form or with simple decoration.

„ (5) A Water Jug, Goblet and Salad Bowl, in plain form or with decoration suitable for cutting.

„ (6) A Flower Vase or Bowl.

In this Section Candidates are earnestly advised to aim at beauty of shape and simplicity of decoration, and they are strongly recommended to make themselves familiar with the essential limitations of pottery and glass in manufacture. Wherever possible they should obtain information from practical workers in these industries as to whether their designs are suitable for reproduction on a commercial scale.

PRIZES OFFERED : First Prizes of £10 10*s*. each will be offered in connexion with each of the groups (1)-(6). The copyright of the designs will remain the property of the successful candidates, who will also be afforded special facilities for selling their designs to the Manufacturers' Associations interested.

SECTION VI.—MISCELLANEOUS.

I.

PRIZE OFFERED BY MESSRS. LEVER BROTHERS, LTD.

Messrs. Lever Brothers, Ltd., offer a Prize of £50 for the best series of Six Lay-outs for Sunlight Soap Press advertisements. The size is 10ins. deep by 6¾ins. wide. In making the award the Judges will take into consideration the following points :—

(1) Composition, in its relation to the main selling point of the advertisement.
(2) Composition, from the point of view of pleasing the eye.
(3) Quality of drawing.
(4) Originality of presentation.

Competitors must bear in mind that their first object must be to present a case for Sunlight Soap in such a way that the beholder will immediately feel, without necessarily exercising any judgment, that the advertisement is for an article of quality ; but they must not be unmindful of the fact that the chief object of any advertisement is to sell something, and that prestige alone is not enough. They should indicate that Sunlight Soap is the purest soap made ; it is, therefore, the most efficient soap made, and, therefore, the most economical soap made. Purity, efficiency and economy are, therefore, the main points to be borne in mind.

No definite instructions as to actual copy are given. It is suggested that competitors should purchase a pound bar of Sunlight Soap and read the story on the wrapper. That story is substantially the same to-day as when it was first written ; but competitors must remember that times have changed, and the method of presenting that story in the Press has altered, as the style of drawing and of copy-writing has altered.

As it is impossible really to design an advertisement unless the artist has before him the actual copy which he is to illustrate, there is no need for competitors to invent headlines or slogans. The letters A, B, C, D, E, F, G, etc., will be quite sufficient to indicate the position of lettering. The object of the competition is to bring out skill in lay-out and treatment.

II.

Cadbury Bournville Travelling Scholarship.

Messrs. Cadbury Brothers, Ltd., offer a Cadbury Bournville Travelling Scholarship of £50 for one year in each of the years 1926-7. The winner will be required to travel on the Continent of Europe for the development of his or her art.

The subject for competition is :—

A set of two designs suitable for Chocolate Boxes :—

(1) For the lid and front of a Display Box, sizes 11½ins. by 7¾ins. and 11½ins. by 2½ins., respectively.

(2) An adaption of this design for a Tied Flange Box, size of top 9½ins. by 8½ins., the lid being 1¾ins. deep.

The designs to be in a decorative symbolic style in not more than four colours, and to embody the following wording : " Cadbury's Bournville [or Tudor or other name] Assortment." " 2 lbs. net." " Made at Bournville."

The award will be subject to the under-mentioned conditions :—

(*a*) The Judges shall be three in number, of whom two shall be appointed by the Royal Society of Arts and one by Messrs. Cadbury Bros., Ltd.

(*b*) The Scholarship-winning designs, with copyright, shall be the property of Messrs. Cadbury Bros., Ltd., who shall further have the right to buy any of the designs which do not win the prize by arrangement with the respective entrants.

(*c*) The designs submitted must be original, and should be of a character that would be understood and appreciated by the general public.

III.

Prizes Offered by Messrs. J. S. Fry & Sons, Ltd.

Messrs. J. S. Fry and Sons, Ltd., offer a First Prize of £17 10*s*., and a Second Prize of £7 10*s*., for each of the following subjects :—

(1) A design for an Exhibition Stand, in plan and elevation to fill a space, roughly, 20ft. by 16ft. (height not to exceed 12ft.).

(2) A design in four or five colours for the Cover of a House Magazine or a Price List.

[The size of the cover and the title of the magazine are left to the discretion of the competitors.]

(3) A design in black and white for a Logotype of " Fry's."

The awards will be subject to the under-mentioned conditions :—

(*a*) The Judges shall be three in number, of whom two shall be appointed by the Royal Society of Arts and one by Messrs. J. S. Fry and Sons, Ltd.

(*b*) The prize-winning designs shall be the property of Messrs. J. S. Fry and Sons, Ltd.

(*c*) The designs submitted must be original, and should be of a character that would be understood and appreciated by the general public.

IV.

Prizes Offered by Messrs. Rowntree and Co., Ltd.

Messrs. Rowntree and Co., Ltd., of York, offer three Prizes of £25, £10 and £5, respectively, for a Window Display Piece for use with (or to carry) their Chocolates, loose, or in boxes or cartons.

The design should be in full colours, and may represent a figure, or portray still-life or architectural subjects. The sketch may be drawn in perspective or made

up in model form ; if the latter, use should be made of such materials as leather-board, beaverboard, or three-ply wood, upon which the design can be painted, possibly in combination with crepe paper, wallpaper, moulding, relief work, etc. The size should not exceed 31ins. in height by 25ins. in width. The word "Rowntree's" must appear in a prominent position. The Window Display Piece may be flat, folding or collapsible, provided the make-up is simple and the erection easy.

The awards will be subject to the under-mentioned conditions :—

(*a*) The Judges shall be three in number, of whom two shall be appointed by the Royal Society of Arts and one by Messrs. Rowntree and Co., Ltd.

(*b*) The prize-winning design shall be the property of Messrs. Rowntree and Co., Ltd., with full copyright and all rights of reproduction, although there shall be no obligation on the part of Messrs. Rowntree and Co., Ltd., to use them.

(*c*) Messrs. Rowntree and Co., Ltd., shall have the right to purchase any other designs, by arrangement with the respective entrants.

V.

Prizes Offered by Messrs. A. J. Caley and Son, Ltd.

Messrs. A. J. Caley and Son, Ltd., offer a First Prize of £30, a Second Prize of £15, and a Third Prize of £5 for a Showcard (size, 15ins. by 20ins. upright) advertising the firm's Chocolates. It is not compulsory to include a slogan, but preference will be given, *cæteris paribus*, to a design bearing a good slogan. The card should be in the least possible number of colours, in order that it may be reproduced inexpensively.

The award will be subject to the under-mentioned conditions :—

(*a*) The Judges shall be three in number, of whom two shall be appointed by the Royal Society of Arts and one by Messrs. A. J. Caley and Son, Ltd.

(*b*) The prize-winning designs shall become the property of Messrs. A. J. Caley and Son, Ltd., and may be used by them for any purpose whatever.

VI.

Prizes Offered by the Underground Group of Companies.

The Underground Group of Companies offer the following Prizes for designs of a Poster suitable for advertising "Underground Railway Season Tickets" :—

Two First Prizes of 10 Guineas each, one for the design showing the most original idea, the other for the design showing the best draughtmanship and execution. The Judges may award the two First Prizes to one design.

Two Second Prizes of 5 Guineas each, on similar conditions.

The designs submitted to be 30ins. deep by 20ins. wide, to be limited to four clear and flat colours, and to be free of all wording.

The awards will be subject to the under-mentioned conditions :—

(*a*) The Judges shall be three in number, of whom two shall be appointed by the Royal Society of Arts and one by the Underground Companies.

(*b*) The prize-winning designs shall be the absolute property of the Underground Companies, with full rights of publication. The Companies, however, shall not be under any obligation to publish.

VII.

Prizes Offered by Messrs. Charles Letts and Co.

Messrs. Charles Letts and Co. offer a First Prize of £20, and a Second Prize of £10, for a design for a Front Endpaper to be used in their Diaries.

The conditions are as follows :—

(1) GENERAL SUBJECT.—The passing of the Seasons.

(2) PARTICULAR SUBJECT.—The transition from Spring to Summer.

(3) SIZE.—In proportion 6¼ins. across by 5ins. deep, but the composition should be of such a nature as to admit of a certain modification of the proportions, as the same design will be used in all editions of Pocket Diaries varying in shapes and sizes.

(4) TYPE.—Designs submitted should be for reproduction in photogravure, and should be in the medium which in the artist's opinion gives the greatest range of tones when reproduced in monochrome.

The awards will be subject to the under-mentioned conditions :—

(*a*) The Judges shall be three in number, of whom two shall be appointed by the Royal Society of Arts and one by Messrs. Charles Letts and Co.

(*b*) The prize-winning designs shall be the absolute property of Messrs. Charles Letts and Co.

In the event of a satisfactory design being submitted, Messrs. Charles Letts and Co. may ask the artist to prepare a Back Endpaper in addition to the Front Endpaper, at a fee to be fixed by mutual arrangement.

"OWEN JONES" PRIZES.

In addition to the Prizes mentioned above, the Council offer six Bronze Medals under the "Owen Jones" Trust to candidates in Class (*b*) British Students in British Schools of Art.

NUMBERS OF ENTRIES.

The number of competitors who entered in all sections of the competition was 550. Of these, 427 were students of Schools of Art, and 123 non-students. The number of designs submitted was 1,753, divided as follows :—

Architectural Decoration (including Wallpaper)	100
Textiles	670
Furniture	152
Book Production	207
Pottery and Glass	94
Miscellaneous—	
Lever Brothers	114
Cadbury Brothers	96
J. S. Fry & Sons	96
Rowntree & Co.	16
A. J. Caley & Son	126
Underground Group of Companies	53
Charles Letts & Co.	29
Total	1753

The Schools of Art from which competitors entered were :—

[The numbers in brackets show the number of competitors from each School.]

Acton and Chiswick Polytechnic (Chiswick School of Art) (2); Ashton-under-Lyne (1); Barnstaple (6); Bath (2); Batley (1) Battersea Polytechnic (11);

Beckenham (2); Belfast (9); Black and White Poster Studios (2); Blackburn (16); Blackpool (1); Bournemouth (11); Bradford (4); Bristol (1); British and Dominions School of Drawing (23); Brixton, L.C.C. School of Building (5); Bromsgrove (1); Burslem (2); Camberwell (6); Cardiff (2); Carlisle (4); Christchurch Technical College, New Zealand (1); L.C.C. Central School of Arts and Crafts (5); City and Guilds South London Art School (1); L.C.C. Clapham (3); Commercial Art Reproduction Training School (2); Croydon (19); Derby (8); Dewsbury (2); Dover (1); Dublin (3); Dudley (1); Dunfermline, Lauder Technical School (4); Eastbourne (1); Edinburgh College of Art (3); Farnborough Secondary School (1); Farnham (5); Folkestone (1); Glasgow (4); Glossop (2); Goldsmith's College (1); Great Yarmouth (2); Guernsey Technical and Art School (1); Guildford (1); L.C.C. Hackney Institute (1); Halifax (7); L.C.C. Hammersmith (6); Hanley (5); Hastings (1); Heatherley School of Fine Art (1); High Wycombe (3); Hornsey (7); Hove (Wick Studios) (3); Hull (1); Hyde (3); International Correspondence Schools (9); Ipswich (2); Keighley (5); Kidderminster (8); Kirkcaldy (1); Leeds (4); Leicester (1); Leyton (1); Liverpool (15); London School of Printing (1); Macclesfield (12) Maidenhead (2); Manchester (24); Margate (4); Newcastle, Armstrong College (1); North London Collegiate School (1); Nottingham (23); Nottingham Correspondence College for Applied Designs (13); Nuneaton (1); Paignton (1); Regent Street Polytechnic (12); L.C.C. Putney (3); Ripon, Skellfield Boarding School (1); Rochdale (4); Rochester (1); Royal Academy Schools (2); Royal College of Art (2); Royal Drawing Society (1); Royal School of Needlework (2); Sale Technical School (1); Sheerness (1); Sheffield (3); L.C.C. Shoreditch (14); Southport (2); Stoke-on-Trent (1); Stourbridge (1); Swindon (1); Toronto, Central Technical School (1); Wallasey (1); Warrington (2); Wellington, New Zealand, Technical College (1); West Bromwich (5); Westminster (3); Wimbledon (1); Windsor Art Classes (1); Wolverhampton (2); Woolwich (4); Wordsley (3).

NAMES OF JUDGES.

The Judges were appointed by the Council on the recommendation of the various Sectional Committees. Their names are as follows:—

ARCHITECTURAL DECORATION.

SUB-SECTION 1. *Prizes for Metal and Glass Front for Lifts offered by Messrs. Henry Hope and Sons, and Messrs. J. W. Singer and Sons, Ltd.*

Arthur J. Davis, F.R.I.B.A.; Stanley Hamp, F.R.I.B.A.; W. H. Haywood F.R.I.B.A.; Clifford Spital.

SUB-SECTION 2. *Prizes for Metal Shop Front offered by Messrs. Bagues, Ltd., and Messrs. Chas. Smith, Sons and Co.*

Arthur Davis, F.R.I.B.A.; Paul Guieu; Stanley Hamp, F.R.I.B.A.; P. A. Stewart.

SUB-SECTION 3. *Prize for Metal Window Frames offered by the Crittall Manufacturing Company Ltd.*

W. F. Crittall; Arthur Davis, F.R.I.B.A.; Stanley Hamp, F.R.I.B.A.

SUB-SECTION 4. *Lewis Berger Scholarship.*

John H. Cantrill; Godfrey Giles.

SUB-SECTION 5. *Wallpaper.*

Professor R. Anning Bell, R.A., LL.D.; H. G. Dowling; L. A. Shuffrey.

TEXTILES.

SUB-SECTION I. *Floor coverings, including Carpets, Rugs, Linoleums and Floor Cloths.*

F V. Burridge, R.E.; E. H. O. Carpenter.

SUB-SECTION 2. *Woven Fabrics for Furniture and Decoration, including Tapestries, Damasks, Brocades, Figured Velvets, Table Damasks and Moquettes.*

Thorold D. Lee; A. J. B. Wace; Sir Frank Warner, K.B.E.

SUB-SECTION 3. *Printed Fabrics for Furniture and Decoration.*

L. P. Butterfield; R. H. Garton.

SUB-SECTION 4. *Printed and Woven Fabrics for Dress, including Brocades, Fancy Dress Fabrics, Handkerchiefs, Tie Silks, Mufflers, Ribbons and other Narrow Goods.*

T. C. Dugdale; A. J. B. Wace.

SUB-SECTION 5. *Machine-made Lace, Lace Curtains and Embroidery.*

A. F. Kendrick; Thomas Muddiman; A. Herbert Woolley.

SUB-SECTION 6. *Miscellaneous, including Hand-made Lace, Embroidery and Open Work, Bedspreads, Cushion Squares, Tea Cosies, Batiks, etc.*

A. F. Kendrick; Thomas Muddiman.

Mr. A. F. Kendrick and Sir Frank Warner K.B.E., (Chairman of the Section) were also appointed general referees in all sub-sections.

FURNITURE.

Octavius Satchell, (Chairman of the Section); W. J. Palmer Jones; C. A. Richter; H. D. Searles-Wood, F.R.I.B.A.; H. P. Shapland, A.R.I.B.A.; L. A. Shuffrey and W. Stewart-Greene.

BOOK PRODUCTION

SUB-SECTIONS I, 2 AND 4. *Title Pages, 3 pages of Text, and Certificate for Royal Society of Arts Examinations.*

C. H. Prentice; J. R. Riddell; C. J. L'Estrange.

SUB-SECTION 3. *Line and Colour illustrations.*

Lawrence Binyon, LL.D.; Emery Walker, F.S A.

SUB-SECTION 5. *Binding*

C. J. L'Estrange; Major R Leighton.

POTTERY AND GLASS.

E. R. Edis (Chairman of the Section); G. D. Francis; J. E. Goodwin; W. Savill.

MISCELLANEOUS

J. A. Milne, C.B.E. (Chairman of the Book Production Committee), in all sub-sections.

Prize offered by Messrs. Lever Brothers, L'd

J. R. Adams; J. R. Riddell.

Cadbury Bournville Travelling Scholarship
Frank Pick; P. B. Redmayne.

Prizes offered by Messrs. J. S. Fry and Sons, Ltd.
Richard Haigh; Frank Pick.

Prizes offered by Messrs. Rowntree and Co., Ltd.
F R Gillett; Frank Pick.

Prizes offered by Messrs. A. J. Caley and Son Ltd.
Frank Pick; Cecil A. Varnon

Prizes offered by the Underground Group of Companies.
Frank Pick

Prizes offered by Messrs. Charles Letts and Co
Major R Leighton; Harry Letts

Reports of Judges.

Architectural Decoration.

Sub-Section 1. *Metal and Glass Front for Lifts.* The Judges were unable to recommend that the full Prizes of £50 and £25, offered by Messrs. Henry Hope and Sons, and Messrs. J. W. Singer, and Sons, Ltd., respectively, should be given. But a First Prize of £25 has been awarded to Leonard Courtney Lewis (166, Crowborough Road, Tooting Common, S.W.17), for Nos. 305, 306 and 307; and a Second Prize of £10 to Jack Ransom Tolson (Leeds School of Art), for Nos. 1220, 1221 and 1222

Sub-Section 2. *Metal Shop Front.* The First Prize of £50 and the Second Prize of £25, offered by Messrs. Baguès, Ltd., and Messrs. Chas. Smith, Sons and Co., respectively, are divided equally between Frank W. McCall (22, Park Road, Wallasey, Cheshire), (Nos. 34, 35, 36 and 37), and William A. Moffoot (24, Third Avenue, Selly Park, Birmingham). (Nos. 1282, 1283, and 1284).

Highly commended:

Hector Currie (L.C.C. Shoreditch Technical Institute). (No. 650).

This competitor submitted no details, and the Judges were consequently unable to consider his eligibility for a Prize.

Commended:

Edward Hamilton Bloomfield (The Tors, Thorburn Road, New Ferry, Cheshire). (Nos. 583, 584 and 585).

For the amount of work shown and care taken in the preparation of his designs.

Sub-Section 3. *Metal Window Frames.* The Prize of 50 guineas offered by the Crittall Manufacturing Company, Ltd., was not awarded, as the judges did not consider that any of the designs were suited for the materials to be used.

Commended:

Philip C. Keen (82, Bradford Street, Bocking, Braintree). (No. 302). The mouldings shown in this design were suitable for wood but not for metal.

William Henry King (Leeds School of Art). (Nos. 1227 and 1228).

SUB-SECTION 4. *Lewis Berger Scholarship.* The quality of the work submitted in this competition is, with few exceptions, below the standard expected by the judges.

The candidates have not, in the opinion of the adjudicators, interpreted correctly the questions set, *e.g.*, Historical development of Colour Decoration has been answered by copies of Historic Ornament without any regard to "development." "Architectural drawings," with two exceptions, merely present ornament without any constructive setting.

The Scholarship is awarded to Vernon Schubert Fawcett (Leeds School of Art).

SUB-SECTION 5. *Wallpaper.*—The subject of this competition was purposely set, but there seems to have been no attempt on the part of the candidates to seriously interpret the type of decoration suitable for a boudoir.

The entries were disappointing. Many designs had to be rejected, and the general standard was low. The prize was hesitatingly given to Thomas James Corbin (No. 1046). This entry showed some originality in selection of motifs, and the treatment of the delicate foliage happily fulfilled its function as a flat decoration.

The judges noted the entry of one of last year's prizewinners (No. 1121), but also regretted to find a repetition of his previous motifs and basis of construction. They could, therefore, only commend him, although the design certainly showed distinct ability.

The awards are as follows:—

Prize of £10 10s. and an Owen Jones Medal to Thomas James Corbin (Croydon School of Art). (No. 1046).

Highly commended:

Miss Alice Rebecca Viney (Farnham School of Art). (No. 959).

Commended:

Miss Kathleen Roy Davis (44, Village Road, Church End, Finchley, N.). (No. 557).

William C. Reeves (Hammersmith School of Art). (No. 1121).

TEXTILES.

SUB-SECTION 1. *Floor Coverings, including Carpets, Rugs, Linoleums and Floor Cloths.* The designs maintained the standard reached last year. Many, however, were on dull and stereotyped lines. Fashion in floor coverings would appear to change slowly, but it is regrettable that there should be not more evidence of a freshness of thought which would meet with public acceptance.

It is encouraging to the judges to be able to give the prize in this Sub-Section to one whose work was highly commended last year.

The awards are as follows:—

Prize of £10 10s. to Walter Shepherd (159, Chester Road, Kidderminster). (Nos. 1270 and 1271.)

Commended :

Cyril Astle (Kidderminster School of Art). (No. 714.)
Miss Dora Bowers (Kidderminster School of Art). (Nos. 586 and 587.)
Miss Janet Campbell (Hornsey School of Art). (No. 1521.)
Norman Lambert (Carlisle School of Art). (No. 773.)

SUB-SECTION 2. *Woven Fabrics for Furniture and Decoration, including Tapestries, Damasks, Brocades, Figured Velvets, Table Damasks, and Moquettes.* Although the number of exhibits is smaller than last year, the level of merit is decidedly higher. The Judges consider there are three designs, not only artistically satisfactory, but well fitted for commercial purposes, viz. :—

No. 610, Linen Damask, by Miss Margaret Barnes (Liverpool School of Art),
No. 778, Wool Tapestry, by J. E. Smith (Carlisle School of Art), and
No. 1132, Silk Tapestry, by Miss Elsie Thompson (Hammersmith School of Arts and Crafts).

Some of the designs were coloured in such a manner as to indicate that the students had not visualised their design as a fabric.

Though the present fashion is in favour of small mats for dining room tables instead of large cloths, it is surprising to find that no designs were submitted of the former. We think that the attention of both designers and manufacturers should be called to this matter.

The awards are as follows :—

A Prize of £10 10*s*. to Miss Margaret Barnes (Liverpool School of Art). (No. 610.)
A prize of £10 10*s*. to Miss Elsie Thompson (Hammersmith School of Arts and Crafts). (No. 1132.)
A prize of £5 5*s*. and an Owen Jones Medal to Robert Leslie Baker (Bath School of Art). (No. 812.)
A prize of £5 5*s*. to John Edward Smith (Carlisle School of Art). (No. 778.)
A prize of £5 5*s*. to Eric Edward Taylor (Battersea Polytechnic School of Art). (No. 1408.)

Highly commended :

Eric Edward Taylor (Battersea Polytechnic School of Art). (No. 1406.)

Commended :

Tom Fraser (Lauder Technical School, Dunfermline). (No. 134.)
William Ephriam Harrison (Blackburn School of Art). (No. 1350.)
John Edward Smith (Carlisle School of Art). (Nos. 779 and 780.)

SUB-SECTION 3. *Printed Fabrics for Furniture and Decoration.* This Sub-Section shows considerable advance on previous years. Conception is unusually good, and many of the designs show much originality.

The awards are as follows :—

Prize of £10 10s. and an Owen Jones Medal to Miss Edith Louisa Vaughan Ailsby (Putney School of Art). (Nos. 1412 and 1413.)

Prize of £10 10*s*. to Miss Evelyn Stiles (Hammersmith School of Art). (No. 128.)
Prize of £10 10*s*. to Miss Ina Taylor (Hanley School of Art). (No. 164.)
Prize of £5 5*s*. to Thomas James Corbin (Croydon School of Art). (No. 1047.)
Prize of £5 5*s*. to Miss Ivy Gwendolene Collyer (Croydon School of Art). (No. 1043.)

Highly commended :

Miss Frances Vera Fluck (Regent Street Polytechnic School of Art). (No. 1551.)
Miss Eleanor Joan Palmer (Manchester School of Art). (No. 1723.)
John Wilson (Hyde School of Art). (No. 937.)

Commended :

John Greenwood (Rochdale School of Art). (No. 890.)
George Ernest Thomas Keyton (Putney School of Art). (No. 1414.)

SUB-SECTION 4. *Printed and Woven Fabrics for Dress, including Brocades, Fancy Dress Fabrics, Handkerchiefs, Tie Silks, Mufflers, Ribbons and other Narrow Goods.* The competition in this Sub-Section was much better this year than last, inasmuch as *taste* seemed better, and a knowledge of purpose was evident to a greater extent than last year.

There was still too little attention paid to "fashion," and many designs were of the kind that belong in period to the "Nouveau Art" of Vienna—circa 1880.

It is a mistake to pay any attention to a "fashion" of a previous day, the only "fashion" worth considering being the current one. A series of fashions inevitably makes a tradition, and tradition can never be ignored, but the fashion to be considered is solely the present one, of the time when the designer is working. It was gratifying to see more economy in the use of colour than usual; charming effects were obtained in some cases by the use of only three—or at most four, colours. This is all to the good, not only from the practical, "producing" point of view, but for artistic reasons. It is always a mistake to use many colours when your effect can be successfully produced by a few. Over-elaboration is always a mistake. In this connection, motifs might be more carefully considered. Many designs contained enough motifs to make half-a-dozen good designs, and by crowding all these into one, the design suffered.

One of the highest qualities to achieve is simplicity, but let it be ingenious, and not bald and obvious.

Elaboration is misleading, and is never admirable, unless it is so discreetly handled that it is in effect simple. The prizes, and commendations, were awarded from the point of view set forth here; so that any student who studies the Exhibition, will readily understand what is meant. It was gratifying to see that, in general, colour was more lively and airy than heretofore, and intelligence in intention was more evident. This is very important to consider, as the intention is often of more value than the actual result, if the intention is clear and the result merely hampered by lack of technical skill. It is important that designs in this section should be executed in flat colour; as, for printing, the engraver must be able to understand clearly what is meant.

Again, taste (which means *good* taste) is the most vital quality, and considerable improvement can yet be shown, although there is a distinct advance on recent years.

The awards are as follows :—

A Travelling Scholarship and a Prize of £5 5s. to Miss Pauline Athey (Manchester School of Art). (Nos. 1672 to 1678.)

Prize of £5 5s. and an Owen Jones Medal to Miss Alice Irene Baron (Edinburgh College of Art). (Nos. 707, 708 and 710.)

Prize of £3 3s. to Miss Violet Robson (Battersea Polytechnic School of Art). (No. 1402.)

Prize of £2 2s. to Arthur Hughes (Macclesfield School of Art). (No. 459.)

Highly commended :

Miss Dorothy Amelot (Hammersmith School of Art). (No. 1118.)
Miss Edith Isabel Nicolson (Edinburgh College of Art). (No. 1197.)

Commended :

Mrs. Margaret Bernard Calkin-James (L.C.C. Westminster Technical Institute). (Nos. 692 to 702.)
Miss Ivy Gwendolene Collyer (Croydon School of Art). (No. 1083.)
Thomas Johnson (Blackburn School of Art). (No. 1354.)

SUB-SECTION 5. *Machine-made Lace, Lace Curtains and Embroidery.* The designs submitted show, on the whole, an appreciation of the situation and needs of the lace industry at the present time. In many cases this has been done without setting aside the tradition of the past.

As far as possible, students' designs should show the effect of the texture itself. Where the lace is intended to be white, or lighter in tone than its background, an ink or pencil line on white paper does not produce the desired effect.

The awards are as follows :—

A prize of £5 5s. to Miss Maud Lilian Cass (Nottingham School of Art). (No. 1589.) The design is sensitive and carefully drawn. While showing the influence of 17th century patterns it has originality. Though much fine detail is introduced into this design, it is so well grouped and the style so consistently maintained that a bold, and even striking, effect is obtained.

A prize of £5 5s. to Miss May Hony (Nottingham Correspondence College for Applied Designs). (No. 366.) A good practical design, though showing less originality of invention than some others. It could be reproduced without alteration or adaptation. The effects of light and shade in the leaves and flowers are happily rendered.

Highly commended :

Miss Daisy Rogers Stedman (15, Carew Road, Ealing, W. 13). (Nos. 198-202.) The designs show skill and originality, but some of the most fanciful parts would lose clearness of definition in mechanical reproduction. No. 199 is the best, but even in that design there is a tendency to excess of detail.

Percy Meadwell, (Nottingham School of Art), (No. 1595.) This design and No. 1594 shows gracefulness of motif and skilful grouping.

Commended :—

Geoffrey Ross Dearden (Nottingham School of Art). (No. 1591.) Commended for simplicity and originality and breadth of treatment.

Frederick William Bartram (Nottingham Correspondence College for Applied Designs). (No. 362.) Design commended for delicacy and refinement. It is true to the character of Chantilly lace, but it would be costly to reproduce on the machine, in common with most designs in lace for parasol-covers.

SUB-SECTION 6. *Miscellaneous, including Hand-made Lace, Embroidery, and Open Work, Bedspreads, Cushion Squares, Tea Cosies, Batiks, etc.* The works submitted in this miscellaneous class are uneven in quality. Some of the embroidery designs are good, but on the whole there is little that is not better represented in parallel groups among the other sections.

The awards are as follows :—

A prize of £5 5s. to Miss Elsie Streeting (Blackburn School of Art). (Nos. 1358 and 1359.)

Highly commended :

Miss Phyllis Hullay (Bradford School of Arts and Crafts). (No. 1742.)
Thomas Isherwood (Blackburn School of Art). (Nos. 1356 and 1357.)
Miss Olive Amelia Trew (Farnham School of Art). (No. 973.)

Commended :

Miss Ida Marion Dight (Brackley, Crofton Lane, Orpington, Kent). (No. 1740.)
Miss Amy Rose Percival (10, Beale Street, Plaistow, E.13). (No. 253.)
Miss Daisy Rogers Stedman (15, Carew Road, Ealing, W.13). (No. 203.)
Miss Beryl Hope Wilson-Smith (Manchester School of Art). (No. 1732.)
Miss Lucy James (Macclesfield School of Art). (No. 465.)
Miss May Rocker (Hornsey School of Art). (No. 1529.)

Furniture.

Sub-Section 1. *Complete Furniture of a Reception Room* (30 *ft. by* 20 *ft.*), *following British Tradition.* The weakness shown by competitors here was that they did not realise that they were treating a room larger than the average, and it is curious that in only one case was it thought that a Reception Room might contain a piano or musical instrument of any kind. There were no wireless cabinets and no gramophone cases. A certain lack of thought was evident in the disposing of the furniture in the room as shown on the sketch plans, the pleasing and convenient grouping of various pieces having been overlooked. In some cases competitors failed to submit any sketch plans whatever, in spite of the fact that the dimensions of the room were specified for their guidance.

The awards are as follows :—

Prize of £20 to Charles Ronald Cater (L.C.C. Westminster Technical Institute). (Nos. 1104 and 1105.)

Highly commended :

Ernest Francis Burgess (74, Fulham Road, South Kensington, S.W.). (No. 814.)

Sub-Section 2. *The Complete Furniture of a Bedroom, following British Tradition.* In this the majority of the competitors ignored the fact that comfortable chairs as well as comfortable beds are needed in a Bedroom. Several 5 ft. beds were included in schemes submitted, though twin beds are now more generally specified. The absence of jewel drawers was noticeable on dressing tables, though in practice these are required together with mirrors of adequate size. The furniture of a Bedroom should be characterised by restful colour and should not be too startling or violent in its proportions: these were the points which weighed with the Judges in their selection. There was, it is true, a *tour de force* in red lacquer perhaps only suitable for a bedroom in Scotland facing due north, but the colour of this might be far less startling if used in a suitable scheme of decoration.

The awards are as follows :—

Prize of £20 and an Owen Jones Medal to Frederick W. Delamare (Christchurch Technical College, New Zealand). (Nos. 503, 504 and 505.)

Highly commended :

James Watson (L.C.C. School of Building, Brixton). (No. 1496.)

Commended :

Ernest Francis Burgess (74, Fulham Road, South Kensington, S.W.). (Nos. 815 and 816.)

Cyril L. White (Nottingham School of Art). (Nos. 1614 and 1615.)

Sub-Section 3. *The Complete Furniture of a Hall Lounge.* Here the main criticism is that very few of these compositions possess those qualities of ease and welcoming comfort which are desirable. The competitors seemed to be in some doubt as to what the complete furniture of a Hall Lounge should consist of. In more than one instance big bookcases more suitable for large libraries, were introduced, and in some others the colour schemes were harsh and disturbing. The winning composition succeeded in being pleasant without being too formal. Perhaps here it may be said that in all the drawings of complete schemes submitted by furniture designers the weakest point appears to be the designing of the fireplace

The awards are as follows :—

Prize of £20 to Patrick Casey (Barnstaple School of Art). (Nos. 1295 and 1296.)

Commended :

James Watson (L.C.C. School of Building, Brixton). (No. 1498.)

Sub-Section 4. *The Complete Furniture of a Living Room suitable for a House in a Housing Scheme.* Competitors in Sub-section 4 showed on the whole the most encouraging set of drawings submitted. There was a real appreciation of the kind of materials to use and the need for simplicity, and above all economy. One of the competitors conceived of the interior furniture for an inexpensive home in the style of the French Renaissance, but he was happily an exception.

The awards are as follows :—

The Prize of £20 is equally divided between Bernard Frankland Dark (L.C.C. School of Building, Brixton), (No. 722), and William Sanders (Barnstaple School of Art). (No. 1294.)

Commended :

Frederick W. Delamare (Christchurch Technical College, New Zealand). (Nos. 506 and 507.)

Leslie Mendenhall (L.C.C. Central School of Arts and Crafts, Southampton Row). (No. 741.)

James Smith (Liverpool School of Art). (No. 630.)

Harold White (L.C.C. School of Building, Brixton). (No. 976.)

Sub-Section 5. *The Complete Furniture of a Board Room.* The Board Room furniture was generally poor. The treatment of such a subject may vary so greatly that the Judges suggest that the Committee might specify a little more closely : for example, the dimensions of the Room, the material to be used, and perhaps more important still, the amount of money which the furniture should cost. In no instance has there been any indication to competitors that there is any definite limit of price. It is true that Sub-section 4 suggests an inexpensive scheme, but even then no definite sum is mentioned. The winning design in Sub-section 5 was one of the best pieces of work submitted in the whole Furniture section and this competitor shows considerable merit in other sections also.

The awards are as follows :—

Prize of £20 to Frederick W. Delamare (Christchurch Technical College, New Zealand). (Nos. 508 and 509.)

Commended:

Edward George Osborn (L.C.C. School of Building, Brixton). (No. 580.)

Cyril L. White (Nottingham School of Art). (No. 1621.)

SUB-SECTION 6. ***A Piece of Furniture which can be used as a Sideboard in a Medium-sized Modern Room.*** The specification "A Piece of Furniture which can be used as a Sideboard," has perhaps confused competitors a little. The designer who takes the prize has understood it. He has managed to keep away from tradition and has submitted a modern piece of furniture, extraordinarily pleasant in colour and outline, which can certainly be used as a Sideboard in a medium-sized room, without proclaiming its purpose too insistently.

The awards are as follows:—

Prize of £10 10s. to Harold White (L.C.C. School of Building, Brixton). (No. 977.)

Commended:

Walter Clarke (Barnstaple School of Art). (No. 1297.)

Francis Edwin Cotton (L.C.C. Shoreditch Technical Institute). (No. 666.)

BOOK PRODUCTION.

SUB-SECTIONS 1, 2 AND 3. We are of the opinion that the exhibits this year show a decided improvement on those submitted in previous years. In most sections it has been difficult to place exhibits in order of merit, but, taken generally, the typographical work is of a good standard. At the same time it was necessary to reject a number of examples which, if the standard of the competition had been realised, we are sure would not have been submitted. Further, we note with interest how mechanical composition has been employed in these competitions.

The awards are as follows:—

SUB-SECTION 1. *Either or both of the following:—(A) a Title Page entirely set from type, with or without Printers' ornaments; (B) a Title Page partly decorated. The Title Pages to be taken from all or any of the following:—*

(*a*). *"Sketches by Boz." Published by Chapman & Hall. Demy Quarto.*

A prize of £5 5s. to William Henry George Adams (350, York Road, Holloway, N.7). (534.)

A prize of £3 13s. 6*d*. to Robert George Fenton (29, Strode Road, Willesden, N.W.10). (No. 1020.)

A prize of £1 11s. 6*d*. to Robert George Fenton (29, Strode Road, Willesden, N.W.10). (No. 1018.)

(*b*). *"The Pilgrim's Progress." Published by Grant Richards (The World's Classics). Crown Quarto.*

A prize of £5 5s. to Henry L. Lewis (London School of Printing and Kindred Trades). (No. 1470.)

A prize of £3 13s. 6*d*. to Ernest Edwin Allen (101, Corporation Road, Croydon). (No. 1140.)

A prize of £1 11s. 6*d*. to Harold Augustus Brookes (18, Northport Street, New North Road, N.1). (No. 1010.)

(*c*). *Journal of the Royal Society of Arts. Demy Octavo.*

A prize of £4 4s. to Frank Wm. Fordham (23, Casewich Road, West Norwood, S.E.27). (No. 1085.)

A prize of £4 4s. to Frank Wm. Fordham. (No. 1086.)

A Prize of £2 2s. to Harold Augustus Brookes. (No. 1011.)

SUB-SECTION 2. *Three pages of Text with Chapter Heading, from any or all of the works enumerated in Sub-Section* 1.

A prize of £6 6*s*. to Ernest Edwin Allen (101, Corporation Road, Croydon). (No. 1145.)

A prize of £4 4*s*. to Ernest Edwin Allen. (No. 1146.)

Highly commended:

Robert George Fenton (29, Strode Road, Willesden, N.W.10). (No. 1023.)

SUB-SECTION 3. *Either* (*a*) *A Line Illustration, or* (*b*) *A Colour Illustration. The subject of the design to be taken from a well-known book, e.g., one included in the World's Classics or Everyman's Library, and to be suitable for illustrating a Crown Quarto page.* The Prize of £10 10*s*. is equally divided between Miss Marjorie Elizabeth Cochrane (Regent Street Polytechnic School of Art, London, W.). (No. 1553), and Miss Joyce H. Davies (Liverpool School of Art). (Nos. 636 to 640.)

Commended:

Arthur E. Barbosa (Liverpool School of Art). (Nos. 641 and 642.)

Miss Joan Ivory Packham (Croydon School of Art). (Nos. 1067 and 1068.)

SUB-SECTION 4. *A certificate in connexion with the Royal Society of Arts Examinations.* A prize of £7 7*s*. is awarded to Robert George Fenton (29, Strode Road, Willesden, N.W.10). (No. 1012.)

A prize of £3 3*s*. to Ernest Edwin Allen (101, Corporation Road, Croydon). (No. 1147.)

Highly commended:

Robert George Fenton. (No.. 1013.)

Frank William Fordham. (No. 1090.)

SUB-SECTION 5. *A Binding for "The Pilgrim's Progress," in either cloth* (*blocked*) *or leather* (*tooled*). The Judges are pleased to note a general improvement this year in the standard of work submitted. The number of exhibits is still rather small. More attention has been paid to designs for cloth binding than hitherto. A point which is inclined to be weak in every case is the method of treatment of the back. In some instances no back was submitted. This must of necessity bar the designs in question from receiving an award.

The Prize of £10 10*s*. is awarded to William C. Reeves (Hammersmith School of Art). (No. 1122.)

Commended:

Miss Evelyn Gray (Battersea Polytechnic School of Art). (No. 1392.)

Miss Doris Pope (Folkestone School of Art). (No. 1193.)

POTTERY AND GLASS.

The designs submitted in the Pottery section show in general a decided improvement on those received in previous competitions and whilst naturally all are not equally good, the Judges did not feel there were any that should be absolutely rejected, but the lack of appreciation of material is still prominent. The prevailing fault is a tendency to over-elaboration, making production unnecessarily expensive, and in many cases practically impossible. At the same time the progress shown is very gratifying and encouraging.

China.

SUB-SECTION 1. *Cup and Saucer, Cream, and Bread and Butter Plate with decoration suitable for Enamelling.* The Judges have pleasure in awarding a Prize of

£10 10s. to Kathleen Waine (4, Argyle Road, Normacot, Longton) for merit displayed in the six designs submitted (Nos. 1156-61), particularly No. 1158. All drawings sent by this Competitor show variety, care and attention to detail, and quite a wealth of ideas, of which 1158 is, perhaps, the best (the saucer in this has too many repeats and should have 6 instead of 8). All are suitable for the material for which they are intended, but in some cases simplification of handles would be an advantage, both for effect and from a manufacturing point of view.

No. 158. Millicent Jane Taplin (Hanley School of Art), is "Highly Commended." This design is very suitable for China, carefully executed, and although somewhat lacking in originality otherwise fully complies with the conditions of the competition, especially in appreciation of the material to be used. The standard in this sub-section is good, but several designs submitted—although of considerable merit—are more suitable for Earthenware than China, and for this reason could not be recommended for awards. On Earthenware one may have a decoration of a somewhat heavy type, but on China it ought always to be dainty and colourful, to suit the lighter material.

Sub-Section 2. *A simple decoration on a Cup.* In this Sub-Section the designs are in most cases promising. Competitors in general realised the necessity of restraint, and most of the designs were quite suitable for the particular shape of cup supplied. The Judges are pleased to award a £10 10s. prize to be equally divided between

No. 1330. Edith Mary White (Derby School of Art), and

No. 159. Millicent Jane Taplin (Hanley School of Art).

They further recommend Edith Mary White for the "Owen Jones Bronze Medal." Miss White's design is carefully executed, particular attention being given to detail, and is capable of being applied in various ways in different colour combinations.

No. 1274, J. Chadwick (Burslem School of Art) is commended.

Earthenware.

Sub-Section 3. *Dinner Plate and Vegetable Dish.* This Sub-section has developed considerably and a decided improvement on earlier efforts is apparent, but the difficulty of production is still not sufficiently appreciated. This applies more particularly to the Vegetable Dishes ; impossible handles are given, and many appear to be more suitable for Metal than Pottery. The material intended should be kept more closely in mind : one may expect lack of technical knowledge which can only be remedied by much longer experience, but more thought could with advantage be given to this point. The fitness of the articles for the purpose to which they are to be put ought to have more consideration. One competitor draws a Vegetable Dish which would really make a small size Soup Tureen, while another uses handles so small as to be out of proportion with the piece, making them of neither use nor ornament. To make the knob on the top of a Vegetable Dish cover stand on four legs may seem a new idea to the Artist, but is not practical, as it would be relatively costly to make and easily broken.

The Judges are pleased to award a £10 10s. prize in this Section to be equally divided between

No. 1331. Edith Mary White (Derby School of Art), and

No. 1210. Norman T. S. Hull (Stoke-on-Trent School of Art).

In 1331 the general effect is good, but some details as regards production are at fault, the handles are too light, and give the effect of metal rather than Pottery; otherwise production is quite practicable.

No. 1210 is suggested to be on "light green biscuit body"; the dinner plate, however, is shown with a white centre. This is not practical, but the design as a whole is well balanced and carefully considered in detail.

No. 1436, Campbell F. Cargill (International Correspondence School, Kingsway, W.C.) is commended. This design shows originality, but is somewhat overdone. The production of the Vegetable Dish as shown is not possible, and has too much decoration on the bottom piece, making it look overloaded as well as being too costly in production compared with the dinner plate. Considerable modification would be an advantage. The whole design, however, shows much attention, and the general effect is good.

No. 348, Gladys M. Olive (Woolwich Polytechnic School of Art) is commended. The Vegetable Dish in this is practical but too deep; the knob is good, but here again the handles are the weakest point, being too small to be either useful or ornamental. In this Sub-section results are encouraging, but the general tendency to overload applies particularly.

Glass.

It is a matter for regret on the part of the Judges that they are unable to award any Prizes in this Section as no individual design attains the all round standard of excellence or originality that merits this distinction. There is a general tendency to overcrowding and elaborate decorations, with intricate detail, which is not in keeping with the modern-day demand; also, there is a lack of originality in the designs, but quite a good knowledge of the possibilities of production is displayed in both shapes and decorations emanating from the Stourbridge district.

SUB-SECTION 4. *A Service of Glass, (i.e., a Wine Glass, a Tumbler, and a Decanter) in plain form or with simple decoration.* No. 870 is "Highly Commended," and is the outstanding design, mainly for its simplicity of form and decoration, and, in addition, is a complete and practical pattern to produce. This is the work of Thos. William Jones, of the Stourbridge School of Art.

SUB-SECTION 5. *A Water Jug, Goblet and Salad Bowl, in plain form, or with decoration suitable for cutting.* Nos. 326 and 328 are "Commended" for a certain amount of originality displayed. This is the work of Charles H. Husselbee of the Wordsley School of Art, who shows promise in these designs. Design No. 871 of Thomas William Jones of the Stourbridge School of Art, also shews decided ability, and is "Commended." John Gill, of Brierley Hill, is "Commended" for his Salad Bowl design (No. 84), which has great merit for excellence of detail, and this is the predominating feature of all his work.

SUB-SECTION 6. *A Flower Vase or Bowl.* This is a disappointing Sub-section, inasmuch as Flower Vases and Bowls offer such great scope for imagination. No. 332, Bowl by Albert Elcock, Wordsley School of Art, is "Commended" for its shape and decoration. No. 872, by T. W. Jones, Stourbridge School of Art, is a distinct and clever design, but is not original.

MISCELLANEOUS.

I.

PRIZES OFFERED BY MESSRS. LEVER BROS., LTD.

The best Series of Six Lay-outs for Sunlight Soap Press Advertisements. The work generally is of a mediocre standard. The idea that an illustration is all-

sufficient seems to run through these entries. The prizes have been awarded to students who have shown neatness rather than creative conception. In designing lay-outs students should aim at balance between illustration, type and white space rather than a pretty or good illustration, leaving space and lettering to look after themselves. Students taking up this work should not follow the popular conception of a lay-out which is in great vogue just now, but create something original, as the purpose in advertising is to catch the public by something which is quite new. It will be seen in the present display of work that this has not been attained. The successful competitors have merely followed work which is appearing in almost every newspaper to-day.

As to treatment in technique, this can be considered with advantage by the students, for some treatments lend themselves to reproduction in the newspapers, while others, of a finer nature, are suitable for magazines only, and quite unsuitable for newspaper printing.

Prizes of £5 each are awarded to :—

Miss Olive G. Bourne (Croydon School of Art). (Nos. 1029 and 1030.)
Miss Dorothy Cullen (Croydon School of Art). (Nos. 1048 and 1049.)
George Robert Fathers (59, Radcliffe Road, Fulham Road, S.W.). (Nos. 493 to 498.)
Miss Louisa S. Knowles (Liverpool School of Art). (Nos. 608 and 609.)
Horace Arthur Stephens (Battersea Polytechnic School of Art). (Nos. 1149 to 1154.)

Highly commended :

Miss Eileen Ashley (Croydon School of Art). (Nos. 1027 and 1028.)
Miss Dorothy Alice Boden (Nottingham School of Art). (Nos. 1628 and 1629.)
Miss Ursula M. Squire (Margate School of Art). (No. 1206.)
Miss Marjorie M. Trueman (Nottingham School of Art). (No. 1662.)

II.

Cadbury Bournville Travelling Scholarship.

Set of Two Chocolate Box Designs. The Cadbury Bournville Travelling Scholarship of £50 is awarded to

William Thomas Rose (Working Men's College Art Class, Crowndale Road, London, N.W.). (Nos. 732 and 733.)

Highly commended :

Joseph Bentham Jenkinson (Liverpool School of Art). (No. 613.)
Gerald Leake Searson (Nottingham School of Art). (No. 1655.)

Commended :

Miss Phyllis Mary Fletcher (Nottingham School of Art). (No. 1641.)
Miss Bertha J. Olyett (Black and White Studios, 12 and 13 Bedford Street, Strand, W.C.). (No. 981.)
Miss Sylvia Paul (Liverpool School of Art). (No. 618.)

III.

Prizes offered by Messrs. J. S. Fry and Sons, Ltd.

(1). *Design for an Exhibition Stand.*

In the designs for an Exhibition Stand, not enough attention was paid to the necessity for displaying the goods, and with very few exceptions the colour and decoration of the stands would outvie the chocolate boxes themselves.

The First Prize of £17 10s. is awarded to:

Edward Hill (56, Old Chester Road, Woodhey, Bebington, Cheshire). (No. 417.)

The Second Prize of £7 10s. is awarded to:

James Watson (L.C.C. School of Building, Brixton). (No. 1501.)

(2). *Design, in four or five colours, for the Cover of a House Magazine or a Price List.*

The title "House Magazine" seemed to mislead many competitors. The treatment of the front cover for a magazine issued by and dealing with a Firm's activities should offer a delightful scope for the artist. The designs for "Price List" covers were poor, and most of the entries were ordinary in conception and treatment.

The First Prize of £17 10s. is awarded to:

Miss Verna C. Stead (Royal College of Art, South Kensington, S.W.). (No. 1502.)

The Second Prize of £7 10s. is awarded to:

Ralph Ramm (7, Queen's Road, Brentwood, Essex). (No. 1345.)

Highly commended:

Miss Daphne Barry (Battersea Polytechnic School of Art). (No. 1389.)

Commended:

Hubert R. W. Hooper (Heathcot, Ashley Heath, Ringwood, Hants.). (No. 403.)

(3). *Design, in black and white, for a Logotype of "Fry's."*

In the design for a logotype of "Fry's," many entrants forgot the prime importance of legibility. Several examples, however, were quite good and original.

The First Prize of £17 10s. is awarded to:

John Francis Smith (2, Alder Grove, Waterloo, Liverpool). (No. 196.)

The Second Prize of £7 10s. is awarded to:

Fred A. Horn (Bradford School of Art). (No. 68.)

Highly commended:

Fred A. Horn (Bradford School of Art). (No. 65.)

Commended:

Norman Biles (Guildford School of Art). (No. 117.)

IV.

Prizes offered by Messrs. Rowntree and Co., Ltd.

In offering prizes for a *Window Display Piece*, Messrs. Rowntree and Co., Ltd. desired to stimulate the interest of Art Students and others in a comparatively new field for Commercial Art. The Judges, however, regret it has not been found possible to award a prize or commend any of the entries. The designs submitted lacked artistic merit and originality, and were, in the opinion of the Judges, quite unsuitable for use in connection with the display of the Firm's products.

V.

Prizes offered by Messrs. A. J. Caley and Son, Ltd.

The Entries as a whole showed great promise. In many instances, however, although well drawn, the designs were not specially suitable for the purpose of advertising chocolates, and would have been more useful for other products. Some of the selected entries, however, showed that very careful thought and consideration had been given to the subject, and the designs and slogans were both appropriate and attractive. It is suggested that more thought be given to the subject of the advertisement in any future competition, and although some designs were highly artistic, they should not lack colour and brightness for the purpose of a confectioner's Window Bill.

Showcards. The First Prize of £30 is awarded to:

Miss Marjorie M. Trueman (Nottingham School of Art). (No. 1661.)

The Second Prize of £15 is awarded to:

Ernest Argyle Oldman (Nottingham School of Art). (No. 1649.)

The Third Prize of £5 is awarded to:

Fred A. Horn (Bradford School of Art). (No. 1243.)

Commended:

Miss Dorothy Thick (Bournemouth School of Art). (No. 796.)
Robert Fidler (Liverpool School of Art). (No. 620.)

VI.

Prizes offered by the Underground Group of Companies.

Season Ticket Posters. The First Prize of £10 10*s.* for the Design showing the most original idea is awarded to:

James Browning (Battersea Polytechnic School of Art). (No. 1380.)

The First Prize of £10 10*s.* for the Design showing the best draughtmanship and execution is awarded to:

Miss Margaret Reynolds (Battersea Polytechnic School of Art). (No. 1396.)

The Second Prize of £5 5*s.* for originality of idea is awarded to:

Miss Norah Francis Staite (Manchester School of Art). (No. 1734.)

The Second Prize of £5 5*s.* for draughtmanship and execution is awarded to:

Gerald Leake Searson (Nottingham School of Art). (No. 1651.)

Commended:

Marcus A. B. Campbell (8, Rue de Montmorency, Boulogne sur Seine, France). (No. 549.)
Miss Faith Gaskell (Battersea Polytechnic School of Art). (No. 1390.)
Fred A. Horn (Bradford School of Art). (No. 1244.)
Miss Frances Emily Penrose (Bournemouth School of Art). (No. 803.)

VII.

Prizes offered by Messrs. Charles Letts and Co.

A Design for a Front Endpaper to be Used in their Diaries. Many of the designs shewed considerable merit, but a number of those who entered the competition rather lost sight of the fact that an essential condition was that the composition

should be of such a nature as to admit of a certain modification of proportion, so that the same design could be used in *various sizes* of pocket diaries. A number of competitors made this impossible by putting a definite border essential to their picture.

Endpapers have, of course, to be folded in two, and certain competitors spoilt their chances of success by arranging the chief figure of the design to come in the centre. Such a design would obviously be spoilt by folding.

Although the entrants were not numerous, the judges, in addition to awarding two prizes, felt justified in highly commending a number of other designs.

The First Prize of £20 is awarded to:
Alfred Kemp Wiffen (Nottingham School of Art). (No. 1663.)

The Second Prize of £10 is awarded to:
Tom Lindsay (The Studio, Clarkston, Glasgow). (No. 1462.)

Highly commended:
Miss Iris Mable Davis (Croydon School of Art). (No. 1055.)
Robert Fidler (Liverpool School of Art). (No. 622.)
Miss Dorothy Cecil Hudson (Wick Studio, Hove). (No. 837.)

Commended:
Miss Ivy Evelyn Norman (Nottingham School of Art). (No. 1647.)
Miss Lilian J. Pocock (24, Warwick Avenue, W.). (No. 250.)
Gerald Leake Searson (Nottingham School of Art). (No. 1654.)

Visit of H.M. the Queen.

The Council have the honour to report that, as in the two previous years, Her Majesty the Queen Visited the Society's Exhibition of Designs at the Imperial Institute, and was graciously pleased to purchase two designs.

APPENDIX.

Complete List of Subscriptions to the Prize and Scholarship Fund for the Years 1924-26.

[Nearly all the money subscribed has been expended in Prizes and Scholarships during the last three years, and the fund is now practically exhausted.]

	£	s.	d.
Messrs. Tootal Broadhurst Lee Co., Ltd.	100	0	0
Messrs. Simpson and Godlee, Ltd.	75	0	0
Messrs. Waring and Gillow, Ltd.	75	0	0
The Federation of Calico Printers	50	0	0
Messrs. Lever Bros., Ltd.	50	0	0
Messrs. Turnbull and Stockdale, Ltd.	50	0	0
British Flint Glass Manufacturers Association	40	0	0
Harold Waring, Esq., C.B.E.	30	0	0
Through John Emsley, Esq., J.P.:—			
Messrs. J. Emsley and Co., Ltd.	30	0	0
Messrs. Peel Bros. and Co., Ltd.	30	0	0
Messrs. John Priestman and Co., Ltd.	30	0	0

	£	s.	d.
Messrs. John H. Smith and Co., Ltd.	30	0	0
Messrs. John Speight, Son and Co., Ltd.	30	0	0
Messrs. John Line and Sons, Ltd.	21	0	0
The Weavers' Company	21	0	0
Messrs. G. P. and J. Baker, Ltd.	20	0	0
Lord Riddell	20	0	0
Royal Institute of British Architects	20	0	0
Sir Frank Warner, K.B.E.	20	0	0
Bookbinding Section, London Chamber of Commerce	15	15	0
Messrs. Brintons, Ltd.	15	15	0
Joiners' Company	15	15	0
Mrs. E. Graydon-Bradley	13	5	0
Messrs. John Brown and Son, Ltd.	10	10	0
Syndics of the Cambridge University Press	10	10	0
The Carpet Manufacturing Co., Ltd.	10	10	0
Carpet Trades, Ltd.	10	10	0
Delegates of the Clarendon Press	10	10	0
Messrs. John Crossley and Sons, Ltd.	10	10	0
Messrs. John Dickinson and Co., Ltd.	10	10	0
The Haberdashers' Company	10	10	0
Messrs. Hampton and Sons, Ltd.	10	10	0
London Cabinet and Upholstery Trades Federation	10	10	0
Messrs. William Heinemann, Ltd.	10	10	0
John Murray, Esq., C.V.O.	10	10	0
Messrs. William O'Hanlon and Co., Ltd	10	10	0
Messrs. Fred Parker and Sons, Ltd.	10	10	0
Messrs. H. and M. Southwell, Ltd.	10	10	0
Messrs. Tomkinson and Adam	10	10	0
Messrs. Chatto and Windus	10	0	0
Sir Bignell G. Elliott, K.B.E.	10	0	0
E. Kahn, Esq.	10	0	0
Messrs. Longmans, Green and Co.	10	0	0
Messrs. Riddick, Stuttart, Ltd.	10	0	0
Messrs. W. H. Smith and Son	10	0	0
Messrs. Henry Stone and Son, Ltd.	10	0	0
Messrs. White, Allom and Co.	10	0	0
Messrs. Story and Co., Ltd.	9	9	0
George Barber, Esq.	5	5	0
Messrs. Bourne and Hollingsworth, Ltd.	5	5	0
Warre Bradley, Esq.	5	5	0
Messrs. Gabe and Pass, Ltd.	5	5	0
John Gibson, Esq.	5	5	0
Messrs. Heal and Son, Ltd.	5	5	0
William Jardine, Esq.	5	5	0
Messrs. Keeble (1914), Ltd.	5	5	0
Messrs. Mander Bros., Ltd.	5	5	0
The Medici Society, Ltd.	5	5	0
Thomas Muddiman, Esq.	5	5	0
Messrs. Neckwear, Ltd.	5	5	0
Federation of Lace and Embroidery Employers' Association	5	5	0
Federation of Master Printers and Allied Trades	5	5	0

	£	s.	d.
Messrs. Shuffrey and Co.	5	5	0
Messrs. Stead, McAlpin and Co.	5	5	0
Messrs. William Thompson and Co., Ltd.	5	5	0
Paul Waterhouse, Esq., F.S.A., F.R.I.B.A.	5	5	0
Messrs. Josiah Wedgwood and Sons, Ltd.	5	5	0
Anonymous	5	0	0
Society of Architects	5	0	0
Messrs. Blackwood, Morton and Sons, Ltd.	5	0	0
Messrs. Crofts and Assinder, Ltd.	5	0	0
Edgar Greenwood, Esq.	5	0	0
Messrs. George G. Harrap and Co., Ltd.	5	0	0
Messrs. A. W. Hewetson, Ltd.	5	0	0
Sir Ernest Hodder-Williams, C.V.O.	5	0	0
Messrs. A. B. Jones and Sons	5	0	0
Messrs. Arthur H. Lee and Sons, Ltd.	5	0	0
Messrs. R. H. and S. L. Plant, Ltd.	5	0	0
Octavius Satchell, Esq.	5	0	0
Percy Scott Worthington, Esq., M.A., F.R.I.B.A.	5	0	0
Stationers' Company	4	4	0
Messrs. Bath Artcraft, Ltd.	3	3	0
Bath Cabinet Makers' Co., Ltd.	3	3	0
Messrs. Collins and Hayes	3	3	0
Empire Bedsteads, Ltd.	3	3	0
C. Erard, Esq.	3	3	0
Messrs. H. Herrmann, Ltd.	3	3	0
Sir Bertram Mackennal, K.C.V.O.	3	3	0
Messrs. G. Allen and Unwin, Ltd.	2	2	0
Messrs. J. Aynsley and Sons	2	2	0
Messrs. J. and W. Bastard	2	2	0
Messrs. Beresford and Hicks	2	2	0
S. D. Bianco, Esq.	2	2	0
Messrs. William Birch, Ltd.	2	2	0
Messrs. A. Cooper and Co.	2	2	0
The Coventry and District Textile Manufacturers' Association	2	2	0
Messrs. Crotty and Polsue	2	2	0
R. D. Earle, Esq.	2	2	0
Messrs. H. S. Fraser, Ltd.	2	2	0
Godfrey Giles, Esq.	2	2	0
A. C. Gill, Esq.	2	2	0
Messrs. Joseph Johnstone, Ltd.	2	2	0
Messrs. W. Skull and Son, Ltd.	2	2	0
Messrs. H. Wilson and Sons	2	2	0
Messrs. G. H. and S. Keen	2	0	0
E. R. Edis, Esq.	1	6	6
F. W. Atkinson, Esq.	1	1	0
A. Barone, Esq.	1	1	0
C. H. Bowers, Esq.	1	1	0
Messrs. J. C. H. Brouwers and Son	1	1	0
H. Bucknell, Esq.	1	1	0
Cedric Chivers, Esq.	1	1	0
The City Cabinet Company	1	1	0

	£	s.	d.
H. J. Colclough, Esq.	1	1	0
Messrs. Dancer and Hearne Bros.	1	1	0
Messrs. S. Epstein, Ltd.	1	1	0
Arthur Keen, Esq., F.R.I.B.A.	1	1	0
S. D. Kitson, Esq., F.R.I.B.A.	1	1	0
The Lanston Monotype Corporation, Ltd.	1	1	0
Messrs. J. Osborne and Co.	1	1	0
Palmer Jones, Esq.	1	1	0
Professor Beresford Pite, F.R.I.B.A.	1	1	0
Messrs. W. W. Ratcliff and Co., Ltd.	1	1	0
C. A. Richter, Esq.	1	1	0
Sir G. Gilbert Scott, R.A.	1	1	0
H. D. Searles-Wood, Esq., F.R.I.B.A.	1	1	0
J. H. Sellers, Esq.	1	1	0
Messrs. I. Sklanowitz	1	1	0
Fred Skull, Esq.	1	1	0
W. Stewart-Greene, Esq.	1	1	0
Percy A. Wells, Esq.	1	1	0
B. R. Field, Esq.	1	0	0
The "X" Chair Patents Co., Ltd.	1	0	0
E. Gomme, Esq.		10	6
H. R. Linton, Esq.		10	6
Messrs. Lotinga Bros.		10	6
Messrs. D. Burkle and Son		10	0
C. Van Doorsselaer, Esq.		5	0
	£1318	9	0

PRIZES AWARDED FOR SPECIAL SUBJECTS.*

	£	s.	d.
Messrs. J. S. Fry and Sons, Ltd.	180	0	0
Messrs. Cadbury Bros., Ltd.	150	0	0
Messrs. Nestlé and Anglo-Swiss Condensed Milk Co.	85	0	0
Messrs. Lever Bros., Ltd.	75	0	0
Messrs. Bagués, Ltd.	50	0	0
Messrs. A. J. Caley and Son, Ltd.	50	0	0
The Underground Group of Companies	31	10	0
Messrs. Charles Letts and Co.	30	0	0
Proprietors of "The Graphic"	25	0	0
Messrs. Henry Hope and Sons, Ltd.	25	0	0
Messrs. Charles Smith, Sons and Co.	25	0	0
Messrs. J. W. Singer and Sons, Ltd.	10	0	0
	736	10	0

* In this list the amounts actually awarded as prizes are given. In several cases the amounts offered were larger, but the Judges did not consider the work submitted deserving of the full awards.

THE CHINESE CARPET AND RUG INDUSTRY.

According to reports recently furnished by United States Consular Officers at Tientsin and Hankow, the demand from foreign countries, especially the United States, is responsible for the development in the production of Chinese rugs from the status of a handicraft, carried on almost exclusively in the home, to an industry with large plants under the supervision of experts. This development has resulted in an improvement in standards of living among the workers, in increasing the wages as compared with other native industries, and in bringing about important changes in manufacturing methods. Aniline dyes and machine-spun yarn have been brought into use with the idea of standardizing and improving the quality of rugs. Although some may regret the passing of the handicraft stage, to others the best type of present-day Chinese rug is superior in texture, dyes, weave and design to its prototype formerly produced in the home. Even though machine-spun yarn may fully supersede the native hand-spun varieties in the manufacture of Chinese rugs, the weaving process will continue to be done by hand so long as a plentiful supply of labour is available.

Most of the Chinese rugs are woven in the north and west. In describing Chinese rugs the term, "Tientsin rug," is sometimes used; but this is simply because the first products of this kind were exported from the port of Tientsin. Although the bulk of the commercial rugs are made in Tientsin and Peking, others of coarser quality are produced in Mongolia, Manchuria (especially Mukden), and other Provinces.

In the use of Chinese hand-spun yarn, the bad feature of lumps is ever present. A careful weaver will cut these out in the process of tying the knot and discard them, which means a loss of material; when they are not taken out they always form a source of trouble in the dyeing process. This does not happen when machine-made yarns are used. Such a yarn presents a better and more perfect dyeing surface, producing an even colour and a minimum loss of yarn to the weaver. The machine-spun yarn in use is principally that spun from Chinese carpet wool, although a small amount of worsted yarn has been imported by a few rug manufacturers. The use of this latter, however, raises the production costs to such an extent that it permits of only limited movements.

A concern in Tientsin erected a plant for the spinning of yarn by modern machinery in 1923. This plant has operated successfully for the past two years, producing about 2,000 pounds of yarn per 24-hour day. Its output is used principally in the making of the firm's own rugs, only a small amount being sold in the open market. This concern uses Chinese carpet wools of the best quality obtainable. The wool is scoured by modern machinery and carded over a double set of breaker and finisher cards, after which it is spun on mules and reeled into six-ply yarn in which the carpet knot is tied. All the yarn is dyed with chrome colours, with the exception of blue, for which synthetic indigo is used. The blue yarn is dyed in the fibre, rather than yarn dyed, as is the case for all other colours, in order to obtain a more even shade. This plant is now adding to its equipment and within a year it will produce about 6,000 pounds per 24-hour day. Such quantities of yarn as can not be absorbed in the manufacture of the firm's own rugs will be disposed of in the market. Another rug manufacturer is installing sufficient spinning machinery to produce 2,000 pounds of yarn per day, and still other concerns are contemplating such installations in the near future.

The trend in Tientsin is distinctly toward the increased use of machine-spun yarns. Rugs thus made are said to withstand the severe chemical wash given them upon their arrival in the United States better than rugs made from the hand-spun yarn.

The Chinese rug designer if left to himself adheres strictly to the conventional and symbolic figures which play an important part in the history of Chinese art. The native designers are very skilful with the brush and some of their designs in water colours are marvels of form and colour, each detail of which is full of significance and intimately associated with the legends and beliefs of the common folk reaching back into a rich historical past.

It is only occasionally nowadays that a Chinese rug which is exported has been designed in strict accordance with Chinese tastes and fancies. The foreign rug expert has changed the designs and combinations of colour to suit foreign tastes.

The principal mechanism in Chinese rug manufacture consists of the deft fingers of the child apprentices. The so-called factories are frequently small and poorly lighted. Shops of this type are owned and supervised by one man who operates on a small scale with limited capital. There are many such establishments in Peking and Tientsin, although in recent years a number of much larger plants have been established, their size warranting the title " factory." Foreign-owned plants cannot compete with the native shops in the production of the regular run of Chinese rugs. Several are able to operate, however, because they produce a grade that can be sold at a price consistent with the higher standard of working conditions maintained.

The majority of the workers in the small rug shops of Tientsin and Peking are apprentices ranging in age from 10 to 16. They are largely recruited from poor families of the rural districts, and the Chinese employer finds it comparatively easy to have his apprentices guaranteed. During the period of service the boy is entirely under the control of the proprietor.

According to figures compiled in March, 1924, of the 6,834 workmen in the rug industry of Peking, only 1,768 were masters or journeymen, the balance (5,066) being apprentices.

The same situation as exists in Peking exists in the majority of the Chinese-owned shops elsewhere. It is the apprentice system in China that makes the manufacturing costs so low, a condition made possible by the huge population and the low productivity of the people in general.

The Chinese rug trade has developed tremendously during recent years, and a much higher quality is now demanded by the market. The system of classification used by the Chinese Maritime Customs during the early years of rug exportation is not such as permits of comparison on the basis of total quantity exported.

A comprehensive idea of the growth of the rug industry in North China can be gained, however, from the following table showing the declared exports from Tientsin to the United States, inasmuch as approximately 90 per cent. of the total is destined for the United States :—

	Square Feet.	Value.
		U.S. Dollars.
1921	2,119,392	1,336,804
1922	2,973,987	2,193,785
1923	4,293,252	3,174,315
1924	5,145,138	4,209,878
1925 (seven months) ..	3,150,423	2,713,487

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THERMOMETRY.

By W. F. Higgins, M.Sc.

Lecture I.—*Delivered March 15th, 1926.*

In dealing with the subject of thermometry it may be of interest to give some consideration to the historical aspect in order to trace the evolution of the thermometer from the early types to the modern instrument. It is somewhat surprising to note that, prior to the later part of the 16th century, no attempts appear to have been made to measure temperature, although the sensations of heat and cold must have been apparent in the earliest days of civilisation. Excavations of Roman houses show that elaborate provision was made for heating the rooms and baths, but there does not appear to be any record of temperature measurements having been made in those days.

The earliest instruments employed for the measurement of temperature can scarcely be called thermometers, but might more aptly be termed thermoscopes, and references to these instruments appear early in the 17th century, from which it may be inferred that the invention of the thermometer dates back to about 1600. The invention has been credited by the early writers to a number of contemporary scientists, among whom may be mentioned Drebbel, Galileo, Sirpi, Fludd and Sanctorius. Drebbel is given on the authority of D'Alence, the writer of a treatise on "Barometers, Thermometers and Hygrometers," published anonymously in 1688, and the date given for the invention is 1608. (Fig. 1). This name and date have been copied by the Abbé Nollet and many other writers. Viviani, in his life of Galileo, written in 1718, however, attributes the invention to Galileo in about the year 1592, and from correspondence between Galileo and Sagredo and other scientists of his time,

FIG. 1.

it would appear that he used thermometers prior to the date ascribed by D'Alence to Drebbel's invention. It is accordingly probable that the thermometer was invented by Galileo between 1590 and 1600. The earliest

FIG. 2.

type of instrument consisted of an inverted flask with a long neck, the end of which dipped below the surface of a liquid contained in an auxiliary vessel. (Fig. 2). On warming the flask some of the contained air was expelled, and on subsequent cooling and contraction of the air, the liquid rose in the neck of the flask. Changes of temperature were then made manifest by changes in the level of the liquid as the air expanded and contracted. The instrument so constructed may be termed an air thermoscope and its indications are influenced by changes in the barometric pressure as well as by changes of temperature. The next step forward was the employment of the expansion of a liquid instead of a gas, and instruments of this style are mentioned in the Proceedings of the Florentine Academy of Science. It is to Ferdinand II, Grand Duke of Tuscany, that the direct forerunner of the thermometer as we know it is ascribed, as, about 1650, he introduced the marked improvement of hermetically sealing the upper end of the thermometer tube. (Fig. 3). The

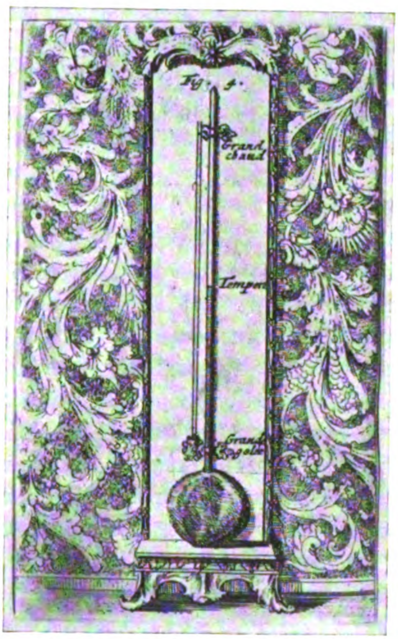
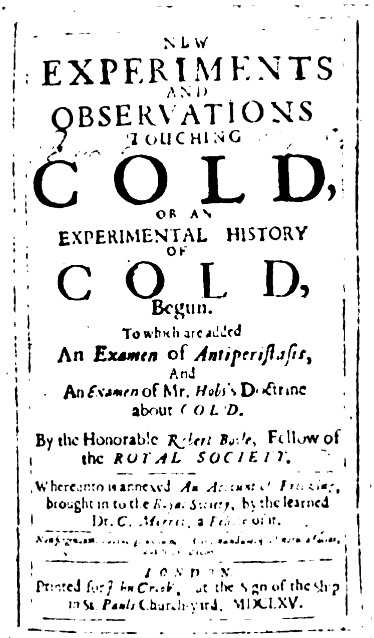


Fig. 3.

thermometers of the Florentine Academy were also provided with scales of degrees. These scales were, however, very arbitrary, and it was not until later that definite methods of standardisation were introduced. Boyle, in 1665, calls attention to the desirability of a standard method of graduating thermometers, and states that the freezing point of distilled water has been suggested as a standard of coldness. In his book " On Experiments touching Cold " (Fig. 4), Boyle points out the advantage of the sealed type of thermo-



NEW
EXPERIMENTS
AND
OBSERVATIONS
TOUCHING
COLD,
OR AN
EXPERIMENTAL HISTORY
OF
COLD,
Begun.
To which are added
An *Examen* of *Antiperistasis*,
And
An *Examen* of Mr. *Hobs's* Doctrine
about COLD.

By the Honorable *Robert Boyle*, Fellow of
the ROYAL SOCIETY.

Whereunto is annexed *An Account of Freezing*,
brought in to the *Royal Society*, by the learned
Dr. *C. Merret*, a Fellow of it.

LONDON,
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in St. *Pauls* Church-yard. MDCLXV.

FIG. 4.

meter, the Florentine weather-glass as he calls it, over the earlier forms which were susceptible to changes of barometric pressure. He also calls attention to the inaccuracy resulting from the lack of uniformity in the thermometer tube, and further suggests the freezing point of oil of aniseed as a suitable temperature for starting the graduation of a thermometer, and that the degrees of the scale should be reckoned as definite increments of expansion of the filling medium. Boyle did not, however, carry this beyond the stage of suggestion. Hooke, about the same time, also put forward a suggestion that the freezing point of water should be used for starting the graduation of the scale. Dr. Halley again raised the desirability of standardising the scales of thermometers, but, thinking that the freezing points of liquids were not constant, suggested that the temperature of an underground cellar should be taken as the starting point for the divisions. His reason for this suggestion is apparently that Boyle had found that the level of the spirit in a thermometer remained constant during the winter and summer at the end of a tunnel cut in the face of a cliff some 80 ft. below the level of the ground and 130 ft. from the front of the cliff. This uniformity of temperature of an underground chamber was confirmed by observations made by Mariotte and de la Hire in the cellars of the Paris Observatory.

Sir Isaac Newton constructed a thermometer filled with linseed oil and adopted a definite scheme of graduation. He measured the expansion of the oil

in his thermometer and marked off his scale proportionately to the expansion; calling the freezing point of water 0° and the temperature of the body 12°. He found that water boiled violently at 34°, tin melted at 72°, and lead at 96°. He also made his celebrated experiments on the rate of cooling of heated bodies and correlated the results with his scale of temperatures. His scale was published in the Philosophical Transactions of the Royal Society in 1701.

It might be mentioned here that the use of linseed oil as a thermometric liquid enables the thermometer to be used above the boiling point of water, and this instrument may in consequence be considered as the precursor of the high range thermometer.

Passing over the work of Amontons and de la Hire, the next stage in the development of the thermometer is due to the work of Fahrenheit, whose scale (slightly modified) survives to the present day.

Fahrenheit used three fixed points in defining his scale, namely, the temperature of a mixture of ice, water and sal ammoniac or salt, the temperature of a mixture of ice and water without added salt, and the temperature of the normal healthy body. The numbers assigned to these temperatures were 0, 32 and 96 respectively. It is probable that in the first instance the number 96 was originally taken as 12, the same as the number of inches to the foot, but owing to the resulting degrees being inconveniently large the figure 96, a multiple of 12, was chosen as being more useful. The boiling point of water was found by him to be 212 on this scale, but it should be emphasised that this temperature was not taken by Fahrenheit as a fixed point. Later when the two points, the temperature of melting ice and of boiling water, were generally adopted as fixed points, Fahrenheit's numbers 32 and 212 were retained, with the result that his original point 96 became nearer 98. Fahrenheit was also one of the first workers definitely to employ mercury as a thermometric liquid, although the use of this had been suggested earlier, and probably instruments had been constructed with it. He pointed out that mercury could be used up to 600° on his scale, but that above this the mercury begins to boil. He also made some of his instruments with cylindrical bulbs instead of spherical, so that the sensitiveness should be increased by the larger surface. Fahrenheit's work dates from 1720 to 1726.

The work of Réaumur about 1730 deserves mention as his scale survives to the present day to a limited extent on the Continent. Réaumur employed spirit thermometers and took the melting point of ice as his one fixed point. The value of a degree was then obtained by assuming that the volume of spirit was 1000 parts at 0°. and that each successive expansion of one part corresponded to a rise of temperature of one degree. On this basis he found the value of the temperature of boiling water to be 80 degrees. He, however, overlooked the fact, as pointed out by Martine, to whom we shall refer again later, that a spirit thermometer cannot be employed up to such a high temperature. Réaumur's figure 80 is taken as the boiling point of water on the scale now

bearing his name, but in view of the above remarks it is obvious that the scale originally employed by him and the present day Réaumur scale are not identical.

The origin of the Centigrade scale of temperature is the next point of interest. The acceptance of the melting point of ice and the boiling point of water as the two fixed points and the division of the temperature interval between these two points into 100 equal parts is due to the suggestion of Celsius of Upsala in 1742, but it is of importance to note that Celsius himself denoted the freezing point by 100 and the boiling point by 0. Inversion of this procedure was proposed by Stormer, a colleague of Celsius, a few years later, while the suggestion had also been put forward independently by Christin of Lyons in 1743.

Before completing the historical résumé of the subject reference should be made to the publication in 1792 of a book by Dr. Martine entitled "Essays on the Construction and Graduation of Thermometers and on the Heating and Cooling of Bodies." Dr. Martine discusses in some considerable detail the discovery and early history of the thermometer and gives a chart comparing the numerous scales which had been proposed from time to time. He also calls attention to the following points:—

(*a*) The variation of the boiling point of water with changes of barometric pressure.

(*b*) The calibration of a thermometer tube by means of a detached thread of mercury.

(*c*) The difference in scales resulting from different kinds of glass.

(*d*) The disadvantages attached to the use of a liquid which wets the glass tube, particularly if the liquid in question is very viscous.

(*e*) The sluggishness of thermometers provided with large bulbs, and he advocates the use of a small bulb combined with a fine capillary to secure a reasonably open scale.

Martine does not, however, refer to the scale of Celsius, although this had been proposed fifty years earlier than the publication of his essays, and it would appear that the Fahrenheit scale was so very firmly established in this country at his time that other scales were not given much attention. Martine's book gives us a very clear idea of the position of thermometry at the end of the 18th century, and by this time it may be said the subject had been put on a fairly satisfactory basis and that later developments concern themselves chiefly with matters of detail. Increase of precision in determination of temperature was called for, as progress in all branches of science demanded increased accuracy of measurement. Further, the provision of greater facilities for improved workmanship, and a widening knowledge of the properties of materials, has reacted beneficially on the science of temperature measurement.

The majority of the thermometers referred to in the historical survey were spirit thermometers, but the use of mercury as a thermometric liquid has been

mentioned. Fahrenheit was one of the earliest workers who employed mercury to any large extent, and it may be of use to consider what advantages mercury has to offer for the construction of thermometers. On examination of the matter it will be seen that these advantages are numerous. Firstly, mercury exists in a liquid state over a wide range of temperature. Its freezing point is about —38°C, while its boiling point is about 356°C under normal pressure. It is liquid over a very large proportion of the range of temperatures which obtain under ordinary conditions, not only for those occurring naturally but for a large part of the range over which scientific work and commercial processes are carried out. At the lower end of the scale we occasionally find that in cold climates temperatures below —40°C. are met with and mercury thermometers cease to function. At the upper end of the scale the working range of a mercury thermometer can be very largely extended by reason of the increase of the boiling point of mercury under pressure. The boiling point of mercury under normal atmospheric pressure is about 356°C. but by increasing the pressure of the gas above the mercury column in a thermometer tube the boiling point may be increased to such an extent that temperatures as high as 550°C. to 600°C. may be measured by means of a mercury thermometer. We will revert to this matter again when dealing with high range thermometers. Secondly, the expansion of mercury is regular, that is to say, mercury does not exhibit any such anomaly as is shown by water, which has a maximum density in the neighbourhood of 4°C. If we employed a thermometer in which water was used as the thermometric liquid, the position of the column at any temperature between 0° and 4° would also correspond to a temperature between 4° and 8° C, and the readings over this range would thus be ambiguous. The expansion of mercury, however, is not exactly proportional to the absolute temperature, so that the normal scale of a mercury thermometer is subject to a small correction to convert the readings to true temperatures; this point will also be dealt with in detail at a later stage.

Again, mercury does not " wet " glass, so that it may be used in a fine bore tube without being held up in the tube by capillary action. This may be considered in the nature of a compensation to one disadvantage which mercury may be said to possess. In comparison with many other liquids its coefficient of expansion is comparatively small, so that in order to obtain a reasonably open scale without unduly increasing the size of the bulb very fine bore tubing must be employed for the stem of the thermometer. This is, of course, one of the main reasons that mercury did not find favour with early workers, as in those days uniform tubing of fine bore was no doubt very difficult or even impossible to obtain. Associated with the use of mercury in fine tubes, it may also be noted that mercury is opaque, so that it can readily be seen in such tubes in which a transparent liquid would be very troublesome to detect. Another minor advantage is the readiness with which mercury can be obtained in a high state of purity by distillation.

The mercury thermometer probably attained its highest degree of perfection in the instruments which were constructed for the International Bureau of Weights and Measures at Sèvres. For the work on standards of length it was necessary to know the temperature of the bars employed to an accuracy of a few thousandths of a degree, and in consequence a comprehensive investigation was undertaken by Chappuis to secure the best means of measuring temperature.

The determination of temperature by means of a mercury thermometer is based on the change of volume of the mercury contained in the instrument, and the magnitude of a degree is given by a definite proportion of the apparent expansion of the mercury between two fixed points. The resulting scale of temperature is a function of the apparent expansion of the mercury in the particular thermometer employed, and its relationship to other scales of temperature will require attention later. For the moment we will consider the case of the Centigrade mercury scale. In this the two fixed points are 0 and 100 degrees respectively. An interval of one degree of temperature is indicated by an apparent expansion of one hundredth of the total expansion between the two fixed points.

It will thus be evident that for a primary standard mercury thermometer the dimensions of the instrument must be such that the mercury shall be visible in the stem of the thermometer at both the temperatures 0 and 100 degrees. If now the positions of the mercury corresponding to these particular temperatures are marked on the stem of the instrument and the volume between the two marks is accurately divided into one hundred equal parts, the intermediate degrees will be obtained. If the bore of the instrument is perfectly uniform the easiest way of dividing the volume into equal parts is to divide the length of the tube between the two fixed points in 100 equal portions. In practice this method is adopted, even when the bore of the tube does not attain perfection, and allowance is made for these imperfections by determining what is known as the calibration corrections. The method of carrying this out will, I think, be made clear if we consider a tube containing a short thread of mercury. If the bore of the tube is perfectly uniform the length of the mercury thread will be the same in whichever part of the tube it happens to be. But if the tube is not uniform its length will change according to the diameter of the tube at the particular position the thread occupies. Thus, at a narrow portion of the bore the length of the thread will be greater than its mean value, while if the thread happens to be at a wider part of the tube its length will be correspondingly less. The variations in internal diameter can consequently be traced out by systematically moving the thread along the tube and noting the change in the length of the thread. It is, of course, assumed that the temperature is maintained constant while this is being done, so that the volume of the mercury is unchanged. In the case of primary standard thermometers the division of the stem is done by means of an accurate dividing engine, and no attempt is

made to adjust the spacing of the divisions according to the bore of the tube. The beginning and end of the scale are adjusted to the two fixed points as nearly as possible, and the intervening length is divided uniformly. In applying the previously-mentioned method of obtaining the calibration corrections the measurements of the mercury threads is made with reference to the divisions of the tube, and not to an independent scale, so that, should the dividing not be quite perfect, the calibration correction being obtained in terms of the divisions of the thermometer itself, automatically allows for the errors of dividing. In using the method for the calibration of a tube the actual procedure is somewhat complicated if the highest accuracy is desired, but for many ordinary cases it suffices if the length of the thread chosen is about one-twentieth of the total length to be calibrated. In the case of a thermometer covering a range of 100°C. this would mean that the average correction for each five degrees would be obtained by the simple calibration process. For precision work this would not be sufficient, and the obvious step is to take a shorter thread, so as to divide the length calibrated into more numerous intervals ; this, however, does not solve the difficulty as the accuracy falls off as the length is made shorter, and also the errors become cumulative as the thread is moved along the tube. The method actually adopted is to start with a long thread and move this along, say one degree at a time, then a somewhat shorter thread is broken off and the operation repeated, and so on until threads of a degree or two are used. Analysis of the observations is then carried out to obtain the most probable error at frequent intervals along the scale. Such a calibration will involve many days or even weeks of work, so that it is obvious that it can only be applied in the case of a limited number of instruments. The simple method is, however, of value in selecting good tubes for making up into thermometers and does not take very long. For good instruments the departure of the tube from uniformity should not exceed an amount corresponding to about one-tenth of a degree at any point over a 50 or 100 degree range.

The next point to which we might give attention is the question of the pressure corrections to a thermometer. In an ideal thermometer the glass bulb would be incompressible, but in actual practice it is desirable to keep the walls of the bulb reasonably thin, so that the thermometer shall not be too sluggish in its action. In consequence external pressure applied to the instrument will slightly compress the bulb (more especially if it is cylindrical and not spherical) and cause the mercury column to rise. Such pressure is experienced if the thermometer is immersed in a bath of water. The greater the immersion the more will be the pressure and the higher will be the reading of the mercury column at any given termperature. With the high precision primary mercury standards of the Tonnelot type the pressure correction is of such an order that variations in the barometric pressure have to be taken into account. The magnitude of the pressure correction is about one ten-thousandth of a degree centigrade for one millimetre change of pressure. This is for a thermometer whose

walls are about ½ mm. thick. The value of the correction for a particular thermometer is determined by supporting the instrument in a closed vessel of water or other suitable liquid maintained at constant temperature and alternately connecting the vessel with the atmosphere, and to an exhausted reservoir to which a manometer is attached. (Fig. 5). Readings of the thermometer are

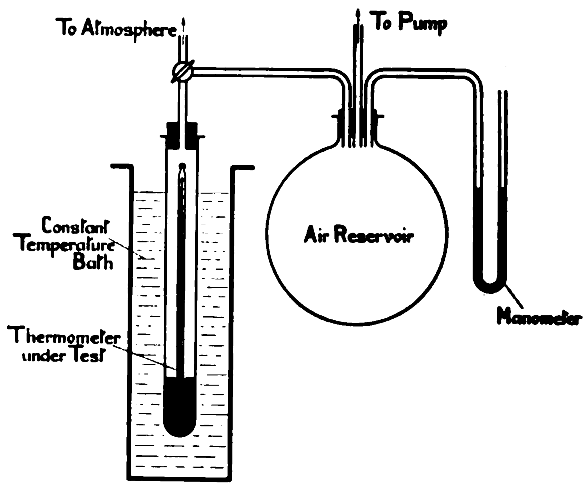

FIG. 5.

taken at a series of pressures and the pressure coefficient calculated from the observations. Over the ordinary range of pressures to which thermometers are likely to be exposed the external pressure correction may be taken as constant.

In the same way that the position of the mercury column depends upon the external pressure to which the instrument is exposed, so also does the effect of the internal pressure due to the mercury column itself have to be taken into account. This internal pressure tends to expand the bulb, so that if the thermometer be used in the vertical position, as is generally the case, the greater the reading of the thermometer the more the bulb is distended, and the more the reading departs from its true value. For thermometers of the type we are considering the magnitude of this correction is about one-tenth of a degree centigrade, when the thermometer is vertical and the mercury is at the upper end of the tube, and at intermediate temperatures may be taken as proportional to the distance from the centre of the bulb. The method by which the correction is determined is to obtain readings of the boiling point when the thermometer is in the horizontal and vertical positions respectively. This is most easily carried out by means of a boiling point apparatus devised by Chappuis, during the course of the work to which reference has already been made.

The three corrections we have so far discussed would enable temperatures to be obtained from the readings of a mercury thermometer, if we assume that

the two fixed points are correctly indicated by the divisions 0 and 100 degrees on the scale. It is, however, an unfortunate property of glass that the volume of a bulb cannot be relied on to remain constant for all time, so that, even when the zero division is correctly marked at the time of the construction of the thermometer, the value of this point would change slightly in the course of time and according to the temperatures to which the thermometer had been exposed. The properties of glass in this respect will receive further attention in due course. The difficulty has been overcome in the case of primary standards by adopting the expedient of obtaining a value of the ice point after each reading of the thermometer and adjusting the actual reading to correspond. We thus regard the scale of the thermometer as moveable, and immediately after each reading we, as it were, slide the scale into such a position that the "0" corresponds to the ice reading taken immediately after the temperature is read. This correction is known as the zero correction.

Further, assuming the zero has been corrected in this way, it does not follow that the 100 division was correctly placed at the start, so that each division of the scale may be slightly longer or shorter than it should be; and on this account a further correction has to be applied. The correction is, of course, obtained by taking the steam and ice points and calculating the appropriate length of a division from the interval between them. This correction is known as the Fundamental Interval Correction. There are thus five individual corrections to be applied to each reading to obtain the true temperature on the mercury scale.

We have so far assumed that our primary standard thermometers cover a range of 100 degrees. For a reasonably open scale, say 7 to 8 mm. per degree, this would involve making the thermometer inconveniently long. There is, however, a way of restricting the range of the thermometer while at the same time retaining the fixed points, which is, as has previously been pointed out, essential in the case of primary standard thermometers. The method adopted is to blow an additional chamber in the bore of the thermometer to accommodate a portion of the mercury. This will be clearer by reference to Fig. 6.

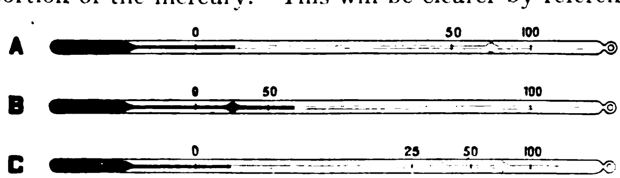

FIG. 6.

For suppose we wish to restrict the scale to 50°C., say 0° to 50°C., a chamber is blown at the position shown (A), of such a volume that on expanding to 100 degrees the excess volume between 0 and 100 degrees is sufficient to just fill this chamber and the adjacent portion of the stem. This introduces a slight complication in the determination of the calibration correction, but the difficulty

is overcome by taking a thread approximately 50 degrees in length and measuring it firstly when one end is at 0°C. and secondly when the other end is at 100°C.; in this way the position of the 50 degree division is determined in terms of the volume contained between the 0 and 100 marks. If the thermometer were required to work over the range 50° to 100° the chamber would be introduced between the 0° and 50° as shown at B in the figure. In a similar way we could make the range of the thermometer still shorter, say 25°, but in this case it would be necessary, in order to be able to carry out the calibration, to employ two chambers instead of one (C), one chamber having a volume corresponding to 25° and the other to 50°.

In calibrating, a thread of approximately 50 degrees would enable the value of the 50 mark to be determined with reference to the two fixed points 0° and 100°, and then a thread of 25° would enable the 25 mark to be evaluated in terms of the 0 and 50 divisions. An alternative method would be to have three intermediate chambers each of volume corresponding to 25°. In any case, when the range of a primary standard thermometer has to be restricted it is necessary to pay particular attention to the provision of suitable subsidiary chambers to enable a full calibration to be carried out.

The standard mercury thermometers supplied to the International Bureau of Weights and Measures were originally made by Tonnelot, a scientific instrument maker of Paris, and on his death the supply of these instruments was carried on by his successor, Baudin. The instruments are consequently commonly referred to as Tonnelot or Baudin thermometers. These thermometers are wonderful examples of the thermometer maker's art and are characterised by the fineness and regularity of the dividing.

The instruments are made of verre dur glass and are not provided with enamelled backs, since it is usual to take readings from the back and front of the instruments to eliminate small residual errors of reading due to parallax or lack of verticality. The fineness of the divisions is such that it is not possible to read the instruments with any degree of comfort without a fairly high-power telescope, e.g., of magnification 10 or 12. In the thermometers ordinarily used the scale is divided to one-tenth of a degree intervals, but the instruments are of such accuracy that it is usual to obtain agreement between the readings of two or three instruments immersed simultaneously in a water bath to an accuracy of two or three thousandths of a degree.

The following table shows an actual series of observation on four thermometers which will perhaps make clearer the application of the various corrections and of the degree of concordance commonly obtained.

It has already been mentioned that the scale of temperatures given by a mercury thermometer differs slightly from the temperatures deduced from other considerations, and this point now requires attention.

Without going into detail it may be stated that on theoretical grounds the scale of temperature which offers the greatest advantage from many points of

TABLE I.

Thermometer Number	4304	4306	16377	16378
Actual readings	17.000	17.050	16.970	17.130
	000	040	970	130
	000	040	970	130
	000	045	980	130
Means	17.000	17.044	16.972	17.130
Calibration correction	—0.038	—0.089	+0.088	—0.069
Internal pressure correction	+0.022	+0.021	+0.029	+0.027
External pressure correction	—0.001	—0.001	—0.001	—0.001
Fundamental interval correction	—0.021	—0.016	+0.001	+0.001
Zero correction (*see below*)	+0.026	+0.025	—0.102	—0.101
Corrected value	16.988	16.984	16.987	16.987
Mean value	16.986			
Difference from mean	+0.002	—0.002	+0.001	+0.001

Zero readings taken immediately afterwards.

	4304	4306	16377	16378
Actual Reading	—0.033	—0.031	+0.093	+0.093
Calibration correction	0.000	0.000	0.000	0.000
Internal pressure correction	+0.008	+0.007	+0.010	+0.009
External pressure correction	—0.001	—0.001	—0.001	—0.001
Fundamental interval correction	0.000	0.000	0.000	0.000
Corrected zero reading	—0.026	—0.025	+0.102	+0.101

view is that known as the thermodynamic scale of temperature. One of these advantages is that this scale does not depend on the physical properties of any definite material. The scale is based on the consideration of an ideal heat engine in which equal increments of temperature are associated with equal increments of work done. It is perhaps needless to say that such a scale is impossible of direct realisation, but it is found that the scale of the constant volume hydrogen gas thermometer reproduces the thermodynamic scale well within the accuracy attainable by the mercury thermometer over the range 0° to 100°C. It, therefore, becomes necessary to obtain by direct experiment the connection between these two instruments. The failure of the mercury in glass thermometer to give temperatures on the thermodynamic scale is due to two factors. These are, firstly, that the expansion of mercury is not strictly proportional to the temperature, and, secondly, that the glass envelope also expands with temperature. To obtain a liquid in glass thermometer which would agree exactly with the thermodynamic scale would involve finding a liquid whose expansion was exactly proportional to temperature as defined on

the thermodynamic scale and also a glass whose volume was independent of temperature. In the latter connection we may note that the coefficient of expansion of vitreous silica is very much less than that of ordinary glasses used for thermometric purposes, so that thermometers made of vitreous silica envelopes should give a scale much more nearly approaching the ideal scale than our usual mercury in glass instruments. This point has not yet been subject to experimental test as, so far, silica thermometers of high precision type have not been obtainable, on account of the difficulty of producing really uniform vitreous silica tubing of fine bore. Again, various types of glass are used in the construction of mercury thermometers, and as these have different co-efficients of expansion it follows that the correction to be applied to a mercury thermometer to reduce it to the thermodynamic scale will depend on the nature of the glass used.

The experimental comparison of mercury thermometers with the gas thermometer has been carried out by Chappuis for the case of the thermometers of the Tonnelot type, constructed of verre dur, and by workers at the Reichanstalt for thermometers of Jena glass. Table II shows corrections to be applied to mercury thermometers of these types to convert the readings to the thermodynamic scale. The magnitude of the correction is about one-tenth of a degree between 40° and 50° where the difference is most marked.

TABLE II.

Temperature	Temperature on Mercury Scale — Temperature on Gas Scale.		
	" Verre dur "	Jena 16‴	Jena 59‴
0°C.	0.000	0.000	0.000
10	0.052	0.056	0.024
20	0.085	0.093	0.035
30	0.102	0.113	0.038
40	0.107	0.120	0.034
50	0.103	0.116	0.026
60	0.090	0.103	0.016
70	0.072	0.083	0.007
80	0.050	0.058	0.001
90	0.026	0.030	—0.002
100	0.000	0.000	0.000

NOTES ON BOOKS.

EXPLORING ENGLAND. AN INTRODUCTION TO NATURE-CRAFT. By Charles S. Bayne. London: Jarrolds, Limited, 7*s*. 6*d*. net.

"There's night and day, brother, both sweet things; sun, moon, and stars, brother, all sweet things; there's likewise a wind on the heath. Life is very sweet, brother; who would wish to die?" This Rommany philosophy makes a

strong appeal to all of us, and if we wish our children or nephews and nieces to be initiated into the lore of the country-side and the wild life of wood, moor and field, we cannot do better than give them a copy of Mr. Bayne's book. It is attractively written and full of a kind of information which is interesting to children, and even to "grown-ups." How many people, for instance, know that the doe rabbit, when she has a family, fills up the entrance of her burrow with sand when she leaves it in the morning, so that no prowling marauder may find it, or are aware of the woodcock's practice of carrying its young from the woods to feed in the marshes, instead of making many journeys to and fro to bring food to the nest. Such a book brings home to one very forcibly the endless variety of the ways in which the instinct of birds and animals has solved its particular problem of survival, of adaptation to environment, and will stimulate the faculty of observation in boys and girls who follow up their study of it by making good use of eyes and ears in their country walks and rambles. Plants, as well as birds and animals, are dealt with, and the illustrations of all of these are excellently reproduced from some extraordinarily good photographs. There is also a useful index. Mr. Bayne's volume will make one of the best possible Christmas or birthday presents for any boy or girl.

THE DIAMOND INDUSTRY IN BRITISH GUIANA.

Diamond mining in British Guiana is the second industry in importance and value of exports, ranking next to sugar, and far outranking the gold industry. Alluvial diamond mining, the only method used up to the present in British Guiana, was first started in the upper reaches of the Mazaruni River in 1890, then extended to the Kuribrong and Cuyuni Rivers, and in 1925 to the Berbice River. The stones first found in the Mazaruni section were of good "water" but of small size, ranging from 10 to 15 to the carat. The stones found in the Berbice section are larger but not quite so good in quality as those from the Mazaruni.

The proved diamondiferous area of British Guiana extends in a northerly and southerly direction from the Potaro River to the Cuyuni River, a distance of 150 miles. and eastward for 40 miles from the foot of the Pakaraima Mountains. The Mazaruni fields, now the most important, are in about the centre of this area. The diamonds are accompanied by certain heavy minerals, such as tourmaline in the amorphous and crystalline forms, black sands consisting largely of ilmenite with some ferro-magnesian minerals, and gold in more or less quantity.

From a recent report by the United States Consul at Georgetown it appears that most of the diamonds produced to-day are found in shallow deposits of quartz pebbles of all colours. The overburden varies from a few inches to 3 or 4 feet, and the pay gravel is from 6 inches to a foot thick. In the deep deposits the gravel is 40 to 50 feet deep, and values in gold and diamonds begin 10 feet from the bottom and improve in depth. Up to the present few of these deposits have been worked, owing to lack of mining knowledge and the difficulty and expense of conveying even the lightest machinery to the diamond fields by the existing means of transportation. It has not been found possible to work to a greater depth than 25 feet in an open cut with manual labour, but wherever bedrock has been reached at this depth the returns have been high. The deep deposits, it is stated, can best be worked by means of a light, cheap plant, and the shallow deposits as at present by the native diggers with the "sluice" and "tom."

In 1924 a washing machine was imported from Kimberley (South Africa), such as is used in the alluvial fields there, and through the use of a machine of this size from 60 to 80 tons can be washed in a working-day. There are now several similar

machines working in the fields, and their use has been found profitable to the owners but very unpopular with the local labourers, who prefer the slow handwork.

After the diamonds are found they are sold to the shopkeepers, who deliver them to the captains of the boats making the return trip to Bartica. There is no accurate method in vogue of keeping track of all the diamonds recovered by individual workers, who are under no compulsion to sell to any particular firm or individual. It is estimated that there are between 12,000 and 15,000 men in the fields at present, and no more than 10 per cent. of them are in the actual employ of any concern. The entire method of mining and handling diamonds in the colony is very primitive.

Nearly all the diamonds are sold locally to buyers representing the various European syndicates, and mailed to London or the Continent.

The production in 1925 amounted to 188,207 carats, valued at $4,057,285, constituting an increase in weight but decrease in value from 1924—184,571 carats, worth $4,097,437. The peak year was 1923, when 214,747 carats valued at $4,958,466, were produced. The output in preceding years was less than in any of the past three. Practically all the diamonds found to date in British Guiana have come from a very small area, which has only been scratched, and where further mining under more scientific conditions may reveal much richer fields. In the future, attention will undoubtedly be given to large areas in the interior in which no prospecting for diamonds or minerals has yet been attempted.

MOTOR TRANSPORT IN SPAIN.

From all parts of Spain, writes the Commercial Secretary to H.M. Embassy at Madrid, reports have been received to the effect that motor transport has made great strides during the year. Districts isolated from the railways have their regular daily service, and numerous lorries of all kinds have made their appearance. In those districts where the roads are only fair, the cheap chassis with a body built by the local cartwright is being used by the small farmer; in the manufacturing districts lorries up to 4-5 tons in weight are now quite common.

The motor omnibus services are generally quite efficient, and, although an attempt was made to grant monopolies to certain lines carrying mails, this was abandoned on account of the pressure brought to bear by the local authorities, who pointed out to the Government that healthy competition was necessary for these services.

American motor manufacturers are reaping the benefit of this development, closely followed by Belgian, French and Swiss, to the practical exclusion of British interests. This is largely attributable to lack of propaganda and inelasticity of sales methods.

A Swiss firm has only established itself by intense propaganda, lasting well over a year, during which they probably did not sell enough to pay for their advertisements. Although their prices are high, they came in at the right moment, and are now reaping the benefit.

The same may be said of a French firm, who have replaced the British 'buses in Madrid, and have a large field of operation for their heavy lorries in Galicia.

Spain is the ideal country for motor transport, owing to its exceedingly mountainous character. Railways will always be costly to construct, and on many sections the agricultural traffic is insufficient to secure adequate returns on capital expenditure. For these reasons alone motor transport must develop, and it is not too late for the British manufacturer to obtain a share of the business if he will only realize that he must change his methods.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THERMOMETRY.

By W. F Higgins, M.Sc.

Lecture II.—*Delivered March 22nd,* 1926.

Mention has already been made of the fact that the zero of a thermometer does not remain fixed, and it is necessary for this to be examined in some detail. The question may be examined experimentally by obtaining the zero point of a thermometer periodically by the usual method of immersing the instrument in pure melting ice. It will then be found that variations occur from time to time, and furthermore that these variations depend on whether the thermometer has been in use immediately before making the observations, or whether the instrument has been laid by for some time. In dealing with this matter, reference will be made repeatedly to zero changes, but it should be made clear at the outset that the changes are manifest at any point along the scale of the thermometer, but it is convenient to refer to the changes of reading as zero changes, as it is so much easier to study the matter by observations carried out at this temperature than elsewhere. Further, the values obtained will be independent of the readings of comparison thermometers, as would not be the case if an attempt were made to trace the changes at, say, 20° C. Occasionally it is more convenient to make observations at the boiling point, for example, with thermometers not graduated down to 0° C., but in this case the correction for changes in the barometric pressure must not be overlooked.

The change in the reading is indicative of a change in the volume of the bulb of the thermometer, and it becomes necessary to see whether all types of glass have similar properties, or whether by suitable choice of material we can

eliminate, or at any rate, reduce the effect. Investigation has shown that the effects do depend to a marked degree upon the nature of the glass employed, and that by suitable choice of the components it is possible to obtain some glasses which are more especially suited to thermometric work than others. In addition to the special requirement that the glass used for the construction of thermometers should show as small a zero change as possible, there are certain other properties necessary, and these may conveniently be dealt with here. The glass employed, especially in the case of high range thermometers, must have a high softening point, in order that the range of the thermometer is not unduly limited. It must also be capable of being worked in the blow-pipe flame without devitrifying or becoming cloudy. The higher the softening point the more difficult is the glass to work, so that instead of employing one type of glass only it is customary to use a more easily worked glass for the construction of low and medium range thermometers, while for high range instruments the more refractory types have to be employed. Further, the glass used for the stem of the thermometer (which need not necessarily be the same as the glass of which the bulb is made), must be capable of giving clear cut divisions when etched by hydrofluoric acid, and it must also be free from inclusions and striae, which would tend to distort the apparent position of the mercury column while readings were being taken. Another desideratum is that the glass shall be capable of being provided with a backing of opaque white enamel to enable the readings to be taken more readily. This point is not essential, although the resultant convenience in use would always favour such a glass in place of a plain tube.

The principal types of thermometric glass used at the present time may be summarised as follows :—

(*a*) English crystal glass or lead glass is largely used for the stems of thermometers of medium range, and is characterised by the clearness of the divisions with which it is capable of being etched, and also by its general brilliancy and good appearance. It is especially suitable for the stems of thermometers of ordinary ranges in this respect, and also by its ease of working, but cannot, of course, be used for high range thermometers, as it has a comparatively low softening point. In composition it is a lead potash glass containing a small proportion of soda. The glass known as "Kew" glass, which, when introduced some 40 or 50 years ago, was a distinct advance on the glass then in common use, is of a similar nature, but this has since been superseded by better types.

(*b*) "Verre dur" is the French glass which is of such importance, in view of the large amount of investigation to which it has been subjected by Guillaume and Chappuis, and it is the glass of which the primary mercury standards dealt with earlier are made. In composition this is essentially a soda-lime glass, and in appearance is characterised by a greenish tinge. It, however, etches well, and is capable of being made into very beautiful instruments. Its zero properties will be referred to later.

(c) Jena 16‴ is one of the two very important glasses made by the firm of Schott and Genossen at Jena. This glass is one of the results of an extensive series of experiments commenced by Schott in 1883, which extended over many years. In these experiments a systematic investigation was made of the effect on the thermometric properties produced by the various components of which glasses can be made. In the course of these experiments several mixtures were obtained which gave excellent results, so far as some thermometric properties were concerned, but which were ruled out from practical consideration on account of other defects ; for example, some could not be worked in the blowpipe flame without devitrification setting in, others were not stable and broke down after a time. Others, again, were not sufficiently resistant to chemical action and were found to dissolve rapidly in acids and alkalis, or even in water, so that the Jena 16‴ was in effect a compromise, in that it had reasonably satisfactory thermal properties combined with the other requirements which have been enumerated earlier. The glass is a soda-lime glass containing zinc oxide and alumina. The designation of the glass is merely the serial and batch number of the experimental melts, and this was retained when the material reached a production basis, to avoid confusion with the many other products of this famous glass factory. It is also referred to as "normal" thermometer glass, but as this term is now of general application, the factory designation Jena 16‴ is probably the most useful means of identification. As most glasses look very much alike, a scheme was adopted of introducing a thin coloured stripe or thread in the process of drawing the tubing. For the Jena 16‴ glass the colour employed is purple. This method of marking glass is a valuable method of identification by inspection.

(d) Jena 59‴ is another glass provided by the Jena factory. This glass is a borosilicate glass, the principal ingredients of which are soda, boric acid and alumina. It is very much harder and more refractory than Jena 16‴, and was specially introduced to provide a suitable material for the construction of high range thermometers capable of being used without risk of softening up to temperatures of 500° to 550° C.

(e) English normal glass. Two English firms, namely Messrs. Powell and Co., of the Whitefriars Glassworks, and Messrs. F. Tomey and Co., of Ashton, Birmingham, produce a normal glass of somewhat similar composition to Jena 16‴, and equal, if not superior to it, in thermometric properties. These glasses are identified by a single and double blue stripe respectively. Borosilicate glasses are also made by Messrs. H. T. Powell and Co., and by the Corning Glassworks of America. There are very little published data relating to the more recently introduced thermometric glasses, but a comprehensive account of the Jena glasses, including many which only reached the experimental stage, will be found in a book entitled "Jena Glass and its Scientific and Industrial Applications," by Hovestadt, one of the co-operators with Schott. This book has been translated into English by J. D. and Miss Everett, so is readily

accessible. The table of percentage compositions of certain glasses as determined by analysis may be of interest, and is shown in Table III.

TABLE III.

Approximate Percentage Composition of Various Glasses.

Constituent.	English Crystal.	Kew Glass.	"Verre dur."	Jena 16‴.	Jena 59‴.
SiO_2	50	53	71	67	72
K_2O	12	11.5	0.5	...	...
Na_2O	1.5	0.5	12	14	10
PbO	34	34	...	...	...
B_2O_3	...	...	...	2	11
CaO	1.5	...	14	7	0.5
Al_2O_3	0.5	0.5	2	3	6
ZnO	...	...	...	7	...
Fe_2O_3, Mn_2O_3, MgO	0.5	0.5	0.5	...	0.5

The figures in the above table must only be regarded as approximate, as individual samples of glass vary considerably; traces of other oxides are found on analysis.

For the experimental investigation of the zero changes which thermometers undergo, any instrument may, of course, be employed, but it is in general more convenient to have special instruments constructed. The essential feature of such experimental thermometers is that they shall be provided with an adequately open scale in the neighbourhood of the zero, and also with chambers sufficiently large to enable the instruments to be heated to any temperature within the range for which the particular glass is suitable. Fig. 7 shows a

FIG. 7.

satisfactory type of instrument for this purpose. A scale extending to about 5 degrees on either side of the zero suffices, and the openness of the scale must be such that each division corresponding to 0.1° C. should not be much less than 1 mm. It is usual to have a second part of the scale corresponding to a range of 5 on either side of the boiling point, although this is not essential. If high temperatures are involved the tube should be nitrogen filled to a suitable pressure, but if it is only intended to study the effects up to 100° C. this is not

necessary, and is perhaps best avoided. With regard to the divisions, it is usual to divide the tube in millimetres, and a preliminary test is carried out to obtain the value of a division. Furthermore, no attempt need be made to obtain exact agreement between the zero division and the ice point, as, owing to the treatment to which the instrument will be subjected, the position of the ice point will change.

If now observations of the ice point be carried out, it will be found that three distinct types of change can be traced. These are known respectively as the Secular Change, the Depression after Heating and the Anneal Effect.

Individual consideration will now be given to each of these types of zero variation.

(*a*) *Secular Change.* If a thermometer be kept indefinitely at the temperature of melting ice the reading of the instrument will not remain constant as might at first be expected, but will slowly rise. The same effect is noted if, instead of keeping the thermometer continuously in ice, it is kept at air temperature, and a reading of the zero is taken at frequent intervals. The change of zero can be traced over a period of many years; for example, Joule kept two thermometers under observation for 40 years, and found that even at the end of this time the zeros were still rising.

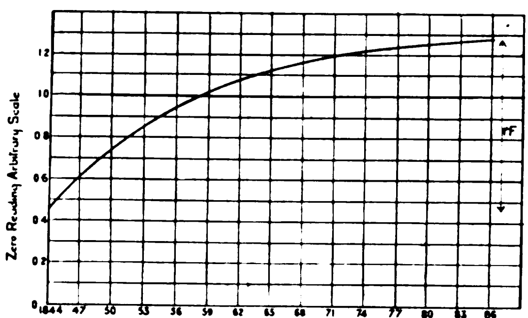

FIG. 8.

Fig. 8 shows the observations for one of Joule's thermometers, and it will at once be seen that the rate of rise of zero decreases in course of time. Similar effects are found with all thermometers, although, fortunately, the magnitude of the change is not so great with thermometers made of modern types of glass as it was for Joule's thermometer of some eighty years ago. For Jena 16''' glass the rise of zero was found by Allihn to be about .04° C. for the first year, and approximately .01° C. per year afterwards. At the National Physical Laboratory similar values have been found to hold for Powell's normal glass. Observations have now extended over a period of more than five years, and during this time the instruments on which the results were obtained have never been exposed to temperatures above that of the air. It may also be of interest to remark here that one thermometer was kept in ice continuously over a period

of about two months, while an exactly similar instrument made at the same time, and from the same batch of glass, was exposed to the normal fluctuations of air temperature during the period. No difference could be detected in the secular change of zero shown by the two instruments.

The secular change of zero is due to the gradual shrinkage of the bulb of the thermometer in course of time. This shrinkage is most probably the result of the very slow release of the strain set up in the glass on solidification.

The effect of secular change is also seen in the case of thermometers subject to the changes of temperature which occur in normal use, but exact measurements are not so easy on account of the masking effect of the other zero changes to which we shall refer later. In this connection I should like, however, to bring to your notice a curious effect observed with one or two batches of standard thermometers in the possession of the Laboratory. Very frequent determinations of the zero are made on all the standard instruments in use, and for the instruments in question it was noted that instead of the normal rise of zero a fall was taking place. It so happened that two or three instruments of the batch had not been put into general use, but had been laid aside as reserves. Their zero had, however, been taken from time to time, and in their case the observations showed the usual rise. Thus, of a batch of thermometers which were similar in all respects, the instruments which were in daily use showed a fall, while those which were in reserve showed the usual rise. The matter was given very careful consideration, and the explanation of the effect which seems most probable is, that the particular glass of which these thermometers were made was rather less resistant chemically than is usual, and that continued use in a well-stirred water bath slowly dissolved away the glass, thereby thinning the wall. The effect of internal pressure was then to gradually expand the bulbs, and thus give rise to the observed fall of zero. The effect seems to have been confined to a limited number of instruments obtained about one period during the war, and must probably be attributed to an accidental variation in the quality of the glass. It may be remarked that the depression value was not in any way abnormal.

To summarise the question of secular change, we may in general say that a thermometer constructed of normal glass will exhibit a slow rise of zero which may amount to 4 or 5 hundredths of a degree in the first year, and in succeeding years will not be greater than about one hundredth. Glasses of a harder type, such as the borosilicates, show a smaller effect, but as these are mainly employed for high range thermometers for which the scale is not so open, the effect of secular change becomes negligible in their case.

(*b*) The second type of zero change which may be observed in thermometers is the depression of zero after heating. If the zero reading of a thermometer be taken immediately before and after the instrument is heated, it will be found that the reading has changed, being in general lower after heating the thermometer than before. The amount by which the reading is lower is known as the

depression of zero of the thermometer. The amount of the depression depends upon the temperature to which the instrument is heated, and also upon the kind of glass used in its construction. It will, of course, be obvious that a glass which shows a big depression value is inconvenient in use, as it generally happens that a thermometer is used for taking a series of observations, and not merely for one particular reading, so that if, during the series of readings, the zero is changing, there is some uncertainty as to what temperatures the readings really mean. It is, therefore, desirable that the glass used shall have a small zero depression, so that the uncertainty shall be as small as possible, or that some definite procedure shall be adopted which allows for the effect. In the case of the "verre dur" primary standard we have already seen that the difficulty is overcome by regarding the scale of the thermometer as if it were moveable, and bringing the readings to a definite starting point by application of the appropriate zero corrections. In ordinary work this method would be somewhat troublesome, so that it is better to employ a glass having a reasonably small zero depression. Furthermore, if it is possible to avoid using a thermometer to measure a comparatively low temperature immediately after employing it for high temperatures, the risk of error due to zero depression will also be reduced, particularly if the instrument has been calibrated on a series of rising temperatures.

In examining a particular glass for zero depression the following procedure is generally adopted. The experimental thermometer such as has already been described is allowed to remain at air temperature for some days, so that it may attain a normal condition, and a zero reading is then taken. The instrument is then immersed in a bath maintained at a definite temperature, say 100° C., for a definite time—a period of thirty minutes is generally satisfactory. On removal from the bath it is allowed to cool rapidly in air, and then as quickly as possible it is returned to the ice bath and a new determination of the zero is made. The difference in readings is the depression value after the particular temperature to which the thermometer has been heated. It is essential that the second ice reading shall be taken as soon as possible after the withdrawal of the instrument from the higher temperature, as the recovery from depression begins very quickly after the instrument has cooled; in fact, if the thermometer be kept in the ice bath it will be seen that the zero begins to rise again within a few minutes of the lowest point being reached. Uniformity of procedure is obtained by taking this lowest reading as the depressed zero. Table IV shows the depression values after temperatures 25°, 50° and 100° C., for a number of the glasses to which a reference has been made. At higher temperatures the values are usually larger, but there is some evidence that in the case of the borosilicate thermometers the depression value reaches a maximum, and then decreases with further rise of temperature. The effects at high temperatures are complicated by changes analogous to the anneal effects which will shortly be discussed.

TABLE IV.

Glass.	Zero Depressions.		
	At 25° C.	At 50° C.	At 100° C.
Kew Glass ...	0.04	0.11	0.22
" Verre dur " ...	0.02	0.05	0.11
Jena 16'''	0.01_5	0.03	0.07
Jena 59'''	0.01	0.02	0.03_5
Powell's normal (blue stripe) ...	0.01	0.02	0.05

In connection with the depression of zero, reference should be made to the recovery of the original value after the zero has been depressed by heating. It has already been remarked that within a few minutes of being transferred to the ice bath the reading will reach a minimum and will slowly start rising again. If observations are continued at intervals of an hour or two it will be found that the zero gradually returns to its earlier value. Different glasses again show a marked difference in the time of recovery. For glasses of small depression value the recovery is practically complete in from 12 to 24 hours, but for glasses like the Kew or verre dur glass, whose depression values are greater, it is a matter of some days before the original zero is even approximately reached.

Preliminary observations on thermometers constructed of vitreous silica have failed to reveal any depression effect.

(*c*) Turning now to the third type of zero change, namely, the effect of anneal, we again find a rise of zero similar to the secular change but of a much greater magnitude. The first time a thermometer is heated it will be found that a large rise of zero may occur; this may amount to many degrees, so that in a properly constructed thermometer a preliminary heating should be given to the instruments before graduation. This preliminary treatment must involve taking the temperature to a higher value than any at which the thermometer is intended subsequently to be used. In fact, the best results are obtained by holding the temperature for a time as near the softening point of the glass as is feasible, and then slowly cooling it. The reason of the large change which takes place on the first heating is that strains are set up in the bulb when the glass solidifies after being blown to shape, and subjecting the thermometer to heat treatment releases these strains and allows the volume to adjust itself. The action may perhaps be made clearer if we consider a hollow sphere of glass at the moment solidification is about to take place. On removal from the blowpipe flame the surface layers of the glass become chilled and solidify, while the inner layers are still in the molten or plastic

state. These inner layers then solidify, but in view of the comparatively low conductivity of glass for heat, a certain amount of time will elapse between the setting of the inner and outer layers. Further, glass contracts on solidification, so that the inner layer tries to contract at the moment solidification takes place, but is prevented from doing so as the outer layer is already solid, and in consequence there is a marked strain or inward pull on the outer layers of the sphere. If now the glass is again heated a certain amount of freedom is allowed to the molecules, and they begin to rearrange themselves, so that the strain is relieved, and as the strain is toward the interior this entails a slight shrinkage of volume. The subsequent cooling must, of course, be slow, or else the uneven rates of cooling of interior and exterior will reintroduce strains. This explanation does not pretend to be complete, as the problem of the cooling of a mass of glass is necessarily very complex, but it may help in showing the necessity for careful heat treatment or anneal of the glass before all the work of pointing and dividing the thermometer is undertaken. It also shows the advantage of making the annealing temperature as high as possible in view of the greater freedom possessed by the molecules at the higher temperatures, and the greater completeness with which they will rearrange themselves in a strain-free condition in a reasonable period of time.

Although we have regarded the secular change, depression of zero and anneal effects from individual points of view, they are all interrelated, and it is difficult to unravel all the changes which take place when a thermometer is exposed to rapid changes of temperature, particularly at the higher parts of the scale.

We will now pass to a rather different aspect of the subject of thermometry, and will briefly consider some of the more important types of instrument which have been designed for the determination of temperatures under ordinary conditions of scientific and industrial use.

The first group we will consider is the rather large group of thermometers of ordinary type which are often designated chemical thermometers, and in conjunction with these attention will also be given to thermometers frequently spoken of as standard thermometers. The main distinction usually made between these is that standard thermometers are generally of better construction and finish, but a fairer division would be to regard standards as those whose divisions include at least one of the fixed points, so that periodic determinations may be made of the zero changes which may have taken place. I should like, however, to suggest that all thermometers of ordinary type, except possibly those of the cheapest class, should have at least one fixed point, preferably the zero, in order that periodic tests of the instrument may be readily made. It is, of course, realised that in the case of thermometers of limited range, this may involve the addition of an auxiliary chamber and consequently additional expense. As, however, thermometers of limited range have reasonably open scales the provision of a fixed point is all the more of importance, if the thermometer is to be used to the limit of accuracy attainable.

In dealing with the various points which arise it will, perhaps, be easiest to consider in detail a typical specification for a thermometer. For the moment we will confine our attention to mercury-in-glass thermometers, and the first point to be settled is the type of instrument required. The thermometer may be either of solid stem or the enclosed scale type. The former is more generally employed in this country, while the latter is very popular on the Continent. The solid stem type is mainly open to the objection that the divisions are etched on the surface of the stem, and that in course of time the medium with which the divisions are filled to render them more easily visible, is apt to be washed away, more especially if the thermometer is used for chemicals having a strong solvent action. Their chief advantage is greater robustness, while further, unless special precautions are taken in the construction, the enclosed scale type is liable to the serious defect that the internal scale may shift within the sheath. In this connection it is highly desirable that all enclosed scale thermometers should be provided with a datum line etched on the outer tube or sheath to provide a means of checking the position of the scale. Another advantage claimed for the enclosed scale type is that there is less liability to error of reading due to parallax, as the scale is close to the mercury column. Provided, however, the stem of the solid stem type is not unduly thick, I do not personally think the risk of error in reading is great if the normal precautions are taken. If a reading telescope can be employed, the error due to parallax may be considered negligible. Some special types of instrument have been constructed from time to time in an endeavour to combine the advantages of the two types of instrument.

Passing on to consideration of the stem, if the thermometer is of the solid stem type, the glass chosen may be the same as that of which the bulb is blown, or, if preferred, may be of lead glass; if the range is not too high, the choice of this is best left to the maker of the thermometer. The diameter of the stem may also require consideration. For solid stem thermometers this will generally be from 5 to 7.5 mm. In addition the tube should have an enamel back for ease of reading unless for the high ranges where borosilicate or combustion tubing is employed. In these cases visibility is enhanced by having the back roughened or ground. For thermometers of the enclosed scale type the external diameter is generally greater, say round about 10 mm.

The bulb of the thermometer is one of the most important features of the instrument and the glass employed must be suited for the range required. The question of glass has already been dealt with, and need not be further discussed here. As regards shape, a cylindrical bulb of diameter not greater than the stem is most generally useful.

The range of the thermometer must, of course, be specified, and with it consideration of the provision of a zero reading, if the range does not already include this. Thermometers can be constructed to cover any desired range, but as far as possible the selection of what might be termed freak ranges should

be avoided. Most requirements would be met by a limited number of standardised ranges comprising intervals of say 50°, 100° or 250°, and I think economy of manufacture might result if makers would give this matter their serious consideration, and if users would also endeavour to restrict their requirements to such ranges.

The range of the thermometer will also settle the question whether the thermometer is to be gas filled or not. For all temperatures above 250° C. it is essential that the space above the mercury shall contain gas under pressure, while it is highly desirable that this should be done for all thermometers whose range exceeds 150° C. The gas ordinarily used is nitrogen, although carbon dioxide is occasionally employed. Up to 250° or 300° a pressure of one atmosphere suffices, but for higher temperatures a greater pressure is necessary to prevent the mercury column from splitting up. Fig. 9 shows the variation of the boiling point of mercury with pressure, and from this will be seen that a pressure of some 16 to 20 atmospheres is necessary in the case of thermometers intended for temperatures up to 500° C.

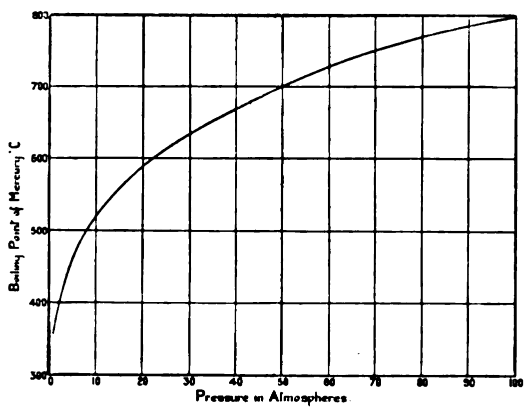

FIG. 9.

In all specifications it should be clearly stated whether the thermometer is to be calibrated for full or partial immersion, and, if the latter, the amount of the immersion must be given. Greater accuracy can be obtained, other things being equal, for thermometers graduated for full immersion, but it must be conceded partial immersion is a great convenience in many cases. The question of emergent column corrections will be dealt with in greater detail later.

The nature of the graduation is to a large extent dependent on the range of the thermometer. For thermometers intended to be read with a telescope of low power the smallest divisions should not be closer than 0.7 or 0.8 mm., while for instruments with which a telescope is not likely to be used a more open spacing is desirable, say not less than 1 mm. In this connection the length of the division lines may also receive attention. The length of the graduations should not greatly exceed their distance apart for the greatest ease in reading.

Thermometers in which the dividing is very close and also very long are most irksome to read. The thickness of the lines is another matter which affects the comfort of reading an instrument. For reading without the aid of a telescope it is a mistake to have the lines too fine, as the eye becomes strained and errors are apt to occur. Going to the other extreme is, however, to be guarded against, as, if the lines are very thick in comparison with their distance apart, subdivision by estimation is rendered difficult, particularly when the column is near a line.

The liability to error in reading is also reduced by attention to the size and frequency of the figuring, and also by the lengthening of the division lines at regular intervals.

The question of dimensions is also a matter which comes up for consideration in drawing up a specification, and an expert thermometer maker is able to work to very close limits in this respect. As far as possible, however, the dimensions of a thermometer should be left as free as possible, as it is obvious that the more rigid the stipulations are, the greater will be the cost of the finished article. Furthermore, care must be taken that the dimensions specified are compatible and are not redundant; for example, if the range, nature and openness of the division are given the minimum length of the thermometer follows. Close specification of the dimensions should only be made when a thermometer is required to be used in conjunction with some piece of apparatus in which the exact size of the thermometer may be of importance.

The following is an example of a typical specification for a thermometer which may help to make clear some of the points to which reference has been made:—

SPECIMEN SPECIFICATION FOR A THERMOMETER.

Type.	Mercury-in-glass, solid stem, nitrogen filled, with expansion chamber.
Stem.	Lead glass, enamelled back, diameter from 5.5 to 6.5 mm.
Bulb.	Normal glass, cylindrical shape, diameter not to exceed that of the stem.
Range.	—2° C. to + 2° C.; 99° to 126° C.
Immersion.	Full.
Dimensions.	Overall length not to exceed 400 mm. Distance from extreme end of bulb to 100 division to be between 100 and 120 mm.
Graduations.	To be divided to 0.1° C., each 0.1° C. to occupy not less than 0.7 mm. Dividing to be short and fine, suitable for reading with a low power telescope. Each 0.5° and 1.0° shall be indicated by longer lines than the 0.1° divisions.
Figuring.	The scale shall be figured at every 1° C.
Marking.	Serial number and " full immersion."

Another very large class of thermometers to which reference should be made are those employed for meteorological purposes. The various points which have already been mentioned regarding mercury in glass thermometers apply equally in these cases, but in connection with spirit thermometers there are one or two matters to which special reference should be made. In the first case the co-efficient of expansion of alcohol is some 6 to 7 times that of mercury, so that for a given size of bulb a much wider capillary tube may be used for the stem to give equal openness of scale while the changes in the glass of which the bulb is made are of correspondingly less importance. It is not, however, desirable to dispense with the use of normal glass except for very rough instruments. The second point is that spirit wets a glass surface, so that there is a tendency for the spirit to cling to the bore of the tube, and care must be taken to cool spirit thermometers slowly, and they should be kept in a vertical position as far as possible to allow the spirit to drain down the tube. The third point to which attention should be drawn is the purity of the spirit employed. Some tests have recently been carried out at the Laboratory with reference to this. A year or two ago it was noted that some spirit thermometers which were being re-tested showed a marked fall of reading since the previous observations were made, and steps were taken to track down the cause of this discrepancy. We were led to suspect the presence of an impurity in the spirit used, and in view of the most probable impurity being acetone, the effect of this material was fully investigated. A full account of the work will shortly be published, but Figs. 10, 11, and 12 will serve to summarise the results obtained. From these it will be evident that special care should be taken to use pure alcohol only in the construction of spirit thermometers.

Among other liquids used in the construction of thermometers should be mentioned pentane, which is used for thermometers of very low range, as this material remains liquid down to very low temperatures.

Another interesting attempt to replace mercury as a thermometric liquid is the use of an alloy of sodium and potassium in approximately equal proportions. This material was introduced with a view to extending the range of

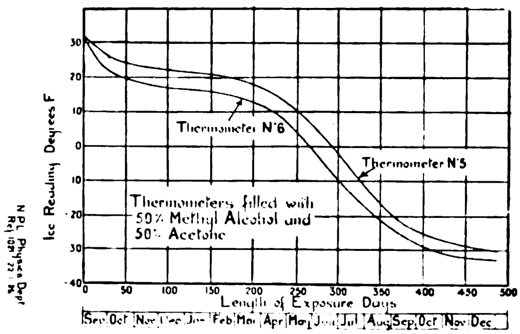

FIG. 10.

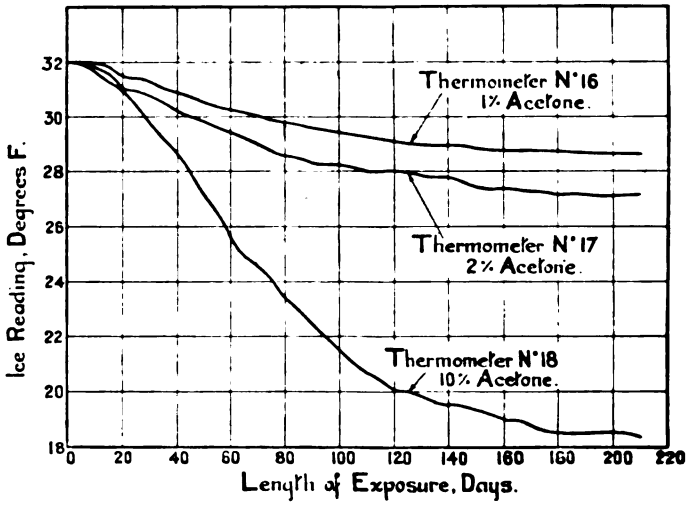

FIG. 11.

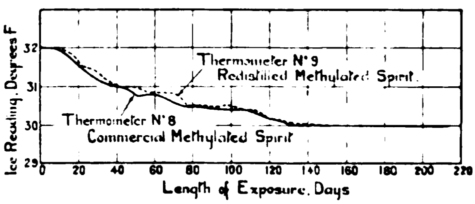

FIG. 12.

liquid in glass thermometers without having to introduce gas into the thermometer tube at very high pressures, as is the case with high range mercury thermometers. Unfortunately, these instruments cannot be regarded as a successful attempt, owing to the extreme chemical activity of the alloy. The smallest trace of air or moisture fouls the surface of the metal, and in addition its activity is such that the glass is slowly attacked, with the result that the bore soon becomes dirty, and the thermometer ceases to function. Quite recently the use of the metal gallium has been suggested by the General Electric Company. Its melting point is about 30° C., and its boiling point is stated to be in the neighbourhood of 2000° C., so that the use of gas under pressure above the column is not required. Vitreous silica is employed instead of glass, so that thermometers of this type can be used up to about 1000° C. It is too early as yet to say whether any special difficulties arise in the use of these instruments.

The use of mercury in glass thermometers affords a very simple method of measuring temperatures, and it may be taken for granted that they will not be entirely displaced by electric or other types of thermometers for many years to come. There is, however, one feature possessed by electric thermometers

which in many cases gives them a very great advantage over the ordinary type of mercury in glass instrument; this is the fact that the indications can be read at a distance from the point at which the temperature is taken. Several attempts have been made to design a mercury expansion thermometer which shall share this advantage with the electric instruments, and one very successful type is the dial transmitting thermometer in which the indications are given by the uncoiling of a spiral of flattened tubing as the mercury in the bulb expands. The capillary connecting this gauge to the bulb may be of any length desired.

OBITUARY.

SOMERS CLARKE.—Mr. Somers Clarke, the well-known ecclesiastical architect died at Mahamid in Upper Egypt on 31st August, at the ripe age of 85. The son of a Brighton solicitor, he was born on 22nd July, 1841, and was apprenticed to the law, which after five years' unwilling servitude he abandoned to enter the office of Sir G. Gilbert Scott. Later, in collaboration with his partner, Mr. J. T. Michlethwaite, he carried out the repair and restoration of many ancient churches, including St. Martin's, Brighton, and the Church of St. John the Divine, Gainsborough, Lincolnshire. In 1897 he was appointed Surveyor of the fabric of St. Paul's Cathedral, for which he designed the electric lighting—the gift of Mr. J. Pierpont Morgan—and the stalls in the chapel of the Order of St. Michael and St. George. He also co-operated with Sir W. B. Richmond in a scheme of internal decoration and was responsible for the removal of Alfred Stevens' Monument to the Duke of Wellington from the small side-chapel where its great merit was insufficiently appreciated to the central position in the nave, for which the monument was originally designed. In 1900 Clarke was appointed architect to the Dean and Chapter of Chichester Cathedral. Retiring from ordinary professional work in 1922, he went to live in Egypt, where he became an honorary member of the Comité de Conservation des Monuments de l'Art Arabe and assisted in the repair of several ancient temples.

Clarke was for 45 years a member of the Society of Antiquaries, on whose Council he had served, and had been a life Fellow of the Royal Society of Arts since 1892. He attended meetings from time to time, and took part in discussions when papers were read on architectural subjects.

NOTES ON BOOKS.

SCIENCE AND ULTIMATE TRUTH. Fison Memorial Lecture, 1926. By the Very Rev. W. R. Inge, C.V.O., D.D., Dean of St. Paul's. London: Longmans, Green and Co.

This is a reprint of the Fison Memorial Lecture which was delivered before the Guy's Hospital Medical School on March 25th, 1926. The lecturer expressly states that he does not wish to assume the role of a Christian apologist, his aim being rather to expound a philosophic position—an attitude towards the problem of ultimate reality—for the acceptance of a scientific audience. Few could be more fitted for such a task than the Dean of St. Paul's, who combines the qualifications

of philosopher, divine, publicist, and—we might almost say—man of the world. His claim to possess also "a scientific conscience" and an intelligent interest in scientific subjects will be generally allowed, and the lecture certainly deserves to be widely read by the audience to whom it is addressed. In the course of a searching criticism of the mechanical and naturalistic philosophy—so popular with scientific men of the last century—which tended to deny reality to anything not susceptible of quantitive measurement, and after rejecting, as not entirely satisfactory, the solution of Hegelian philosophy, which seems to deny transcendence to God and to make His existence dependent upon the existence of human beings, the lecturer, in a lucid discourse, adumbrates the general outlines of the solution offered by the Platonists —an eternal world of ultimate values and a world of becoming in which by the will of the Creator these values seek outward expression. Such a solution, in the lecturer's view, best accounts for the facts, and enables us to establish the most satisfactory and intelligible relation between the world of being or reality and the temporal world.

GENERAL NOTES.

British Industries Fair, 1927.—Ten thousand square feet of space in the London section of the British Industries Fair to be held next February has been taken by the Empire Marketing Board for a display of Empire food products. The Department of Overseas Trade is making arrangements on behalf of the Board for the construction of a stand and the organisation of collective exhibits and for this purpose is in communication with the High Commissioners and other representatives in London of the Dominions and Colonies. The cost is being met by the Empire Marketing Board from the grant of £500,000 made by Parliament this year for promoting the sale of Empire foodstuffs.

Empire Council of Mining and Metallurgical Institutions.—On the invitation of the Canadian Institute of Mining and Metallurgy the second (triennial) Empire Mining and Metallurgical Congress will be held in Canada in August-September, 1927. The opening session will be held in Montreal on Monday, August 22nd, 1927. Further sessions will be held in Toronto, Winnipeg and Vancouver, and the programme will include visits to mines and works, and places of scenic beauty throughout the Dominion. The full programme will occupy about six weeks in Canada.

The Canadian Minister of Mines has emphasised the direct interest and support of the Dominion Government by accepting an invitation to act as President of the Congress, and offers of hospitality have been received by the Organising Committee from Municipal Authorities and others in all parts of the Dominion whilst excellent travelling facilities and concessions have been offered by Shipping Companies and Railway Authorities.

The fullest information will be embodied in a comprehensive series of communications to be issued to members of the Constituent Bodies by the Organising Committee, through Mr. George C. Mackenzie (*Secretary of the Canadian Institute of Mining and Metallurgy*), the General Secretary of the Congress, Drummond Building, Montreal, Canada.

The Empire Council and the Organising Committee hope that members of the Constituent Institutions will make every effort to take advantage of this exceptional opportunity of inspecting the mines and works of the Dominion and of seeing Canada under such favourable conditions, and also bring the Congress to the notice of other interested persons.

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Copies of the above lectures can be obtained from the Secretary Royal Society of Arts.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THERMOMETRY.

By W. F. Higgins, M.Sc.

Lecture III.—*Delivered March 29th, 1926.*

To obtain the greatest accuracy in the use of a mercury thermometer the instrument should be completely immersed in the medium whose temperature is required. By complete immersion is meant that the whole of the mercury column and not only the bulb must be exposed to the temperature being measured. It is, in practice, not always convenient to do this, and it then becomes necessary to ascertain whether a correction can be applied to allow for the fact that the whole of the mercury column is not at the same temperature as that in the bulb. Suppose for example, the bulb is immersed in a bath of water or other liquid whose temperature is higher than that of the air while the stem of the thermometer projects from the bath and is freely exposed to the surrounding air. In this case the mercury column will indicate a temperature slightly lower than that of the bath, the actual amount depending upon the difference between the temperature and that of the air and upon the length of the column exposed. Since we know the co-efficient of expansion of mercury it is possible to calculate the amount by which the reading will be too low, but this calculation is somewhat uncertain as it is very difficult to say exactly what is the mean temperature of the mercury in the emergent portion of the stem. It is obviously not all at the temperature of the bath, neither is it wholly at the temperature of the surrounding air, because mercury is a fairly good conductor of heat, and, in consequence, the mercury near the bulb will be warmer than that near the more distant end of the column. One method of

making the correction is to assume that the average temperature of the column is the mean of the air temperature and that of the bath, while an alternative method is to use an auxiliary thermometer placed in contact with the stem of the thermometer under consideration at a point midway along the exposed mercury column. The first method is satisfactory in cases where the temperature of the bath is not greatly above that of the air, but if a fairly high temperature is being measured the second method is better.

We will assume that one of these two methods has been employed to obtain the mean temperature of the mercury column, then the correction to be applied to the thermometer reading is the product of the number of degrees exposed, the difference between the temperature of the bath and the mean temperature of the mercury column and a constant, the value of which depends to a small extent on the kind of glass used in the construction of the thermometer. For temperatures measured on the centigrade scale, the value of the constant is approximately 0.00015.

It is of interest to take a concrete case. Suppose we have a thermometer whose range is 0° to 450°C., and that it is immersed up to the 50° reading in a bath whose temperature is 400°C. Further, let us assume that an auxiliary thermometer is placed with its bulb halfway up the column and that in this position its reading is 100°C. Then the correction to be applied to our instrument to allow for the amount of the exposed column is obtained as follows:—the number of degrees exposed is 400—50 = 350°. The temperature of the bath is 400°, and from this has to be subtracted the average temperature of the mercury column, namely, 100°, that is, the exposed mercury column should be 400—100 or 300° hotter than it really is, then multiplying together 350, 300 and our constant 0.00015 we obtain the result 16°. Hence our thermometer will be indicating a temperature 16° lower than the true temperature of the bath. This figure may seem somewhat large, but it is quite a reasonable value for a thermometer of this type. At the highest ranges thermometers may show an error of as much as 30° to 40°C, so that the application of a suitable correction is of importance.

There is, however, another method which may be employed to obviate the application of a correction each time the instrument is employed, and this is by having the instrument divided in such a way that the reading of the instrument gives a direct measure of the corrected value of the temperature. Such a thermometer is said to be calibrated for partial immersion and the amount of the particular immersion for which the graduations are applicable should be engraved on the stem to avoid risk of error by using the thermometer at other immersions. Partial immersion thermometers will only give correct readings when used under the same conditions as those for which the instrument was divided, and for this reason the method is mainly used for thermometers intended for use with some definite piece of apparatus. Further, as we have already seen, the correction depends on the mean temperature of the emergent column as well

as upon the number of degrees exposed, so that a thermometer graduated for partial immersion will only give correct readings if the temperature of the stem is the same under the conditions of use, as when the dividing was carried out.

From the foregoing remarks it will be seen that there is always a slight doubt remaining when a temperature is measured with the instrument not fully immersed, whether a correction is applied or whether the instrument is one which has been graduated for partial immersion, so that to obtain the greatest accuracy complete immersion should be arranged.

Another point in the use of a thermometer which calls for consideration is the question of the thermometric lag. It is, of course, well known that when a thermometer is plunged into a medium at a temperature different from that of the instrument itself, a certain time must elapse before the thermometer picks up the temperature and indicates the true reading. In the large majority of cases this is not a matter of any great importance, as sufficient time can usually be allowed for the reading to become steady, but a case which does sometimes arise is that in which the temperature being measured is itself changing, and on reflection we may ask whether the thermometer does ever catch up to the moving temperature. In actual point of fact, the thermometer does not do so, and it is of interest to see by how much the thermometer lags behind the temperature being measured. It may be shown mathematically by applying Newton's law of cooling that the amount which the reading lags behind the temperature is equal to the product of a constant and the rate at which the temperature is changing. The constant is dependent solely on the dimensions and type of the thermometer, and it is assumed that the temperature is changing at a constant rate.

The value of the lag constant is determined by immersing the thermometer in question in a bath kept at a constant temperature and noting the reading at frequent intervals until the temperature becomes steady. This is a matter of some little difficulty at first and especially in the early stages of each experiment, as the mercury column is moving very rapidly, but as the column gets nearer to the final reading its rate of movement slows up and more accurate observations can be made. The work is greatly facilitated by the use of a recording chronograph, the times at which the mercury column passes definite graduation marks being recorded.

A curve then may be plotted showing readings at definite times, and its shape will be such as is shown in Fig. 13. To evaluate the constant the curve is, however, plotted in a slightly different manner. Any convenient temperature is taken as a starting point, and a new curve is drawn connecting the time which has elapsed from the starting point against the logarithm of the difference of reading between the starting temperature and the temperature at each interval of time. The new curve, Fig. 14, will be found to be a straight line, and the slope of this line gives the lag coefficient of the thermometer.

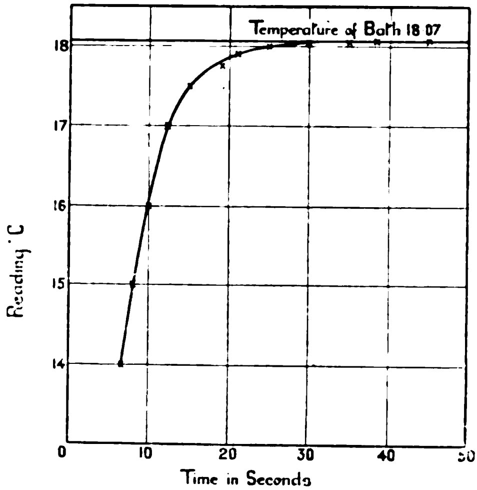

FIG. 13.

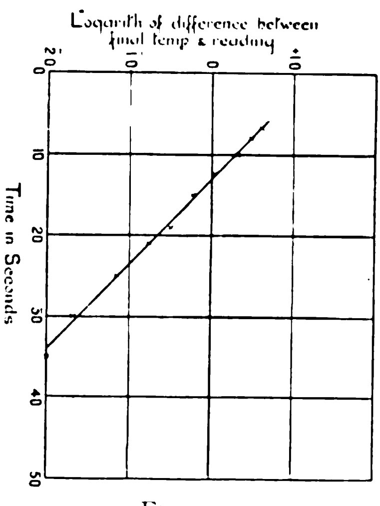

FIG. 14.

For the ordinary type of the chemical thermometer the lag coefficient is about 5 seconds. This does not mean that the final reading of the thermometer will be attained in 5 seconds, but that in this time the difference in reading of the thermometer and the true temperature will be reduced to $1/e$,* i.e., about 2/5 of its value at the start. For example, if the thermometer was originally 10° below the temperature to be measured, at the end of 5 seconds the difference will only be 4°, at the end of another 5 seconds the difference will be about 1.6°,

*e is the base of Naperian logarithms and is equal to 2.718...

while at the end of 35 seconds from the start the difference will be down to about 0.01°C. On the other hand, if the temperature of the bath is rising steadily instead of being constant, the thermometer will lag behind by an amount which is obtained by multiplying the rate of change of temperature by the constant 5. Thus, if this rate is 1° per minute (i.e., 1° per 60 secs.) the thermometer will show a reading about 0.08°C. below the true value.

The necessity for applying this correction is one which does not often arise, but the foregoing examples may serve to show that it is possible to allow for the lag of a thermometer when such occasions do occur.

The next part of the subject of thermometry with which we shall deal is the testing of thermometers, and most of the remarks will also apply to the pointing of thermometers in the course of manufacture.

The use of primary standards has already been dealt with at length, and the methods of testing about to be described will deal with the comparison of ordinary types of thermometers against such primary standards, or against sub-standards or working standards, which have themselves been compared with the primary standards. At this point it should perhaps be mentioned that outside the working range of the primary mercury standard thermometers, namely—40° to 100°C, some other standard has to be employed. Up to a temperature of about 600°C, which more than covers the range in which we are interested, the platinum resistance thermometer is adopted as the standard method of obtaining temperatures.

The determination of the two fixed points has already been referred to, but there are one or two details of manipulation to which further reference should be made.

For the determination of the ice point the first essential is that all risk of contamination with soluble salts must be most carefully avoided, and to this end the block of ice from which the shavings are made should be thoroughly washed, to remove surface impurities. The ice selected should be clear and transparent, and in the days when Norwegian lake ice was available there was very little probability of the material being other than of the highest purity. Nowadays, when practically all the ice obtainable is artificially made, greater care must be taken in selection, as it is sometimes found that the block is contaminated with salt from the brine tanks in which it is made, and in consequence it is desirable that a test for dissolved chlorides should be made with silver nitrate solution. If the slightest cloudiness is obtained in applying this test the block of ice should be rejected. Assuming, however, that the ice has been shown to be pure, the next stage is to convert it into shavings, which should be very thin and uniform, and free from lumps. The most effective way of doing this is by means of an ice plane, which is to all intents an inverted carpenter's plane, against which the block of ice is pushed, and the shavings which fall through the mouth of the plane are collected in a clean box. To serve as an ice bath practically any type of vessel may be employed, but a very convenient form is an inverted bell

jar of glass or earthenware. Ample depth should be allowed so that the thermometer when fully immersed to the zero is not close to or touching the bottom of the bath. The bath is packed tightly with the ice shavings, and distilled water is then added, until the mass is saturated with water. The thermometer, whose ice point is required, is then introduced into the bath ; to avoid breakage a hole should be made with a glass rod. This must be vertical, so that when the thermometer is put in place it will also be vertical. The ice is then again well pressed down, and as soon as the reading has become steady its value is obtained.

To obtain the upper fixed point a hypsometer is used. This is essentially a tube through which steam is passed from a boiler. It is jacketed in such a way that the steam, after passing up the tube, is then diverted down an outer co-axial tube to prevent condensation on the bulb of the thermometer. The steam is then allowed to pass into a condenser, the remote end of which must be open to the atmosphere, to ensure that the water is boiling under atmospheric pressure. A reading of the barometer must be taken at the same time, in order that the necessary correction for the change in boiling point with pressure may be made.

Turning now to the direct comparison of thermometers with standard instruments, we will first consider the range between the two fixed points for which water is by far the most convenient medium in which the comparison is effected. The essential feature in any comparison bath, whatever the medium used, is that the medium shall be efficiently stirred so that the whole of the region in which the thermometers are placed shall be at the same temperature. This entails that the liquid used shall be in violent motion ; it is not sufficient that the liquid shall be gently agitated or shall be slowly flowing round the bath, as in these cases it is quite easy for portions of the liquid to remain at different temperatures. The type of bath which is most effective in securing thorough agitation is one in which are provided vertical tubes with cross connections at the upper and lower ends. One tube contains a propeller and the heating units, while the other receives the thermometers being compared.

For a water bath electric heating is found to be very convenient. From six to twelve heating units are employed according to the size of the bath. One type of bath used at the National Physical Laboratory has eight heating units, each of which is capable of dissipating about 400 watts, so that in all a total of about three kilowatts can be used. This enables the bath to be heated at a fairly rapid rate, so that but little time is lost between readings at different temperatures. Provision is also made for holding the temperature steady at any point by using only one or two heater units, and in addition a variable resistance in series with one of the heaters enables fine adjustment of the current to be made to permit of accurate temperature control. Thermostatic devices are not employed to hold the temperature steady owing to the slowness with which they operate. It is quite easy after a little practice to hold the temperature of a bath steady for prolonged periods by manipulation of the switches and resis-

tances in view of the large heat capacity of the baths. Another point in the design is that the heater units are carried in very thin copper pockets, so that the transfer of heat from the heater to the water is very rapid, and the heaters themselves are made of small heat capacity and with the minimum thermal insulation to assist in this. In consequence the temperature of the bath responds very quickly to changes in the heating current, so that adjustment to any desired temperature can be very expeditiously carried out, a matter of great importance when dealing with a large number of instruments or in making tests at frequent intervals of temperature.

Various methods are employed for holding the thermometer under test. Cages with spring clips are employed for clinical thermometers or meteorological thermometers, which are dealt with in large numbers, and which do not differ greatly in dimensions, while for other classes of thermometers a useful plan is to employ cages in which the thermometers are slipped through holes of an appropriate size and held in position by rubber bands. A system of graded collars enables the various sizes of thermometer stem to be adequately dealt with. This method lends itself equally to thermometers which are tested fully immersed as well as those for which corrections are required for a definite partial immersion.

With regard to the readings it is usual to make these with the aid of a telescope for the better class instruments, or with a hand lens for clinicals and meteorological thermometers. In all cases, however, not less than two standards are employed and readings are taken in a definite order and are then repeated in the reverse order. The object of this is to allow for any gradual changes of temperature that have been taking place during the time occupied in making the observations, for assuming the temperature is rising uniformly and the observations are made at a constant rate, the mean reading for each of the forward and backward series will correspond to the mean reading of the standard thermometer.

For temperatures above 100°C it is, of course, impossible to use water, so that other media must be employed. For temperatures between 100° and 200°C oil is the most convenient liquid to use, while from 200° to 500°C a fused salt bath is employed. The baths again are of the type previously described, in that they consist of two vertical tubes with cross connections at the upper and lower ends, but modifications in construction are made to meet the special requirements of the higher temperatures.

Fig. 15 shows the design of salt bath employed. This is constructed of cast iron and is heated by gas. In this connection it must be remembered that most substances contract on solidification, and the material ordinarily used in these baths, namely, a mixture of equal parts of nitrates of soda and potash, affords no exception to the general rule. Consequently, the heating of the bath must be so arranged that, when starting up, the upper parts are heated first, so that the solidified salts start melting from the top, otherwise the expansion will cause the vessel to burst. This is effected by carrying the hot gases up an outer

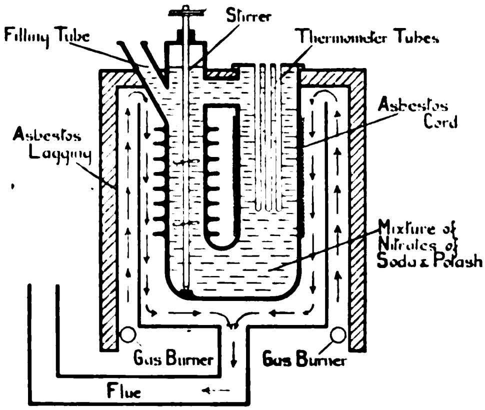

FIG. 15.

iron casing and then down in contact with the walls of the bath itself. Furthermore, fused salts will generally react with glass after a time, so that to protect the instruments they are not directly immersed in the molten nitrates, but are supported in thin walled steel tubes closed at the lower end. This cannot be

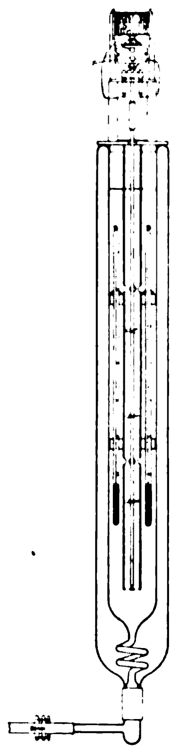

FIG. 16.

regarded as quite so satisfactory as direct immersion in a liquid, but as the accuracy called for in high range thermometers is not so great as for the more moderate ranges the point is not of great importance.

Turning to low range thermometers, the comparison of instruments below 0°C is best carried out in vacuum walled vessels of the cylindrical type. The liquid used can be acetone, ether or alcohol, suitably cooled, e.g., by the addition of solid carbon dioxide. In this way temperatures as low as —80°C can be obtained. Stirring of the liquid may be accomplished by means of the device shown in Fig. 16 or by bubbling air through the cooled liquid.

In the course of these lectures an endeavour has been made to touch upon the main points which arise in the determination of temperatures by liquid in glass thermometers, and to show that accurate determination of temperature can be made by the aid of relatively simple instruments, provided reasonable precautions are taken in their use and subject to the application of the necessary corrections appropriate to the conditions of employment of the thermometer.

Electrical temperature measuring instruments offer advantages in a few special cases, but in view of their greater complexity and cost mercury thermometers will retain their position for many years to come. There is little probability that any marked innovations will arise in the case of mercury in glass thermometers, but there is still room for improvement in construction, both as regards accuracy and finish, in the case of many of the instruments now offered for sale.

There is one direction in which we may look for improvement, and that is in the substitution of clear vitreous silica for glass. At present the production of uniform capillary tubing is difficult and costly, but it is to be hoped that in a few years these difficulties will be overcome and the silica thermometer will become an every-d·· article.

NOTES ON BOOKS.

On the Teaching of Poetry. By Alexander Haddow, M.A. London: Blackie and Son, Ltd. 2s. 6d. net.

This small book is intended for the guidance of students in training colleges and for young teachers of English in schools. Mr. Haddow's treatment of his subject is eminently practical, and his careful exposition of the methods of teaching to which he has found children most responsive will be found very useful. His two main conclusions are: first, that to give children an appreciation of good poetry the teacher must himself be a lover of poetry—that it is waste of time and money for poetry to be taught by a person who does not care for poetry and approaches the lesson as if it were a lesson in spelling or arithmetic; secondly, that the teacher's aim throughout should be to bring the children into direct contact with the poet as expressed in his poetry—without touching on biographical details except incidentally, if it should be necessary to do so to explain some phase or characteristic of the poetry, and only to bring in the assistance of criticism when the children know the poem and have given it their own interpretation. Mr. Haddow has a

number of hints to offer as to the technique to apply in order to carry out these principles, and his book can be recommended to all students and teachers who think they have still something to learn as to the best method of handling this rather difficult subject.

THE MAGALLANES TERRITORY OF CHILE.

An interesting report on the Magallanes Territory of Chile during the past year has been compiled by H.M. Vice-Consul at Punta Arenas, from which the following extracts have been taken :—

The Magellan Territory has no political representation in the Chilean Congress, and is administered more or less on the same lines as a Crown Colony, with a certain amount of self-government. The area is over 66,000 square miles, but a great portion of this is either uninhabited desolate rocky country, or impassable forest land.

The peculiar geographical and political situation of the territory enables it to pursue its own development to the exclusion of all extraneous interests. The climate and the nature of its soil have given it its one industry, viz., sheep-farming and subsidiary trades, and it is due exclusively to the development of this industry in the last fifty years that the territory has attained its present wealth and high level of prosperity. The importance of sheep-farming in Magallanes may be gauged by the fact that the assessable value of the buildings, etc., on the estancias or sheep farms, is nearly two hundred million pesos, while the real value is probably three times this figure. Just as nitrate predominates in the north, so wool and frozen mutton hold undisputed sway here.

The population of Magallanes is about 37,000, of whom about 27,000 live in the town of Punta Arenas. By the very nature of its development foreign colonies are well represented, but the universal language is, of course, Spanish. Weights and measures in use are metric, but in this matter, as in the question of currency, the close commercial associations which the territory holds with London make the use of sterling and British units of weight and measure in the export trade not unknown. Articles for the retail trade are invariably listed in metric weights at Chilean currency prices.

Trade.—In appendices to the report details are given of the steady advance which the territory maintains commercially. The fact must strike the uninitiated reader very forcibly of the disparity between the exports and imports. In 1924 Magallanes exported over one hundred million gold pesos' worth of goods as against less than ten millions' worth bought. The reason is that the majority of the sheep farming concerns have their head offices in the north of Chile, and most of the shareholders in these companies reside outside the territory. In the last report of the largest sheep farming company in Chile, it is stated that the receipts from the sale of wool amounted to about £750,000, while the amount allotted to dividends was over £600,000. Only a small portion of this latter sum returned to Magallanes so that it may be said that the immense wealth derived from the territory is not of itself an indication of the buying power of the inhabitants. The import trade of the district is directly dependent on the sheep industry.

It is noticeable that the percentages of imports from France and Germany are gradually increasing. The competition is felt mostly in textiles and manufactured goods. A local agent has built up quite a large postal business with drapery houses in Paris, and the demand for these goods is increasing to the detriment of the retail houses established at Punta Arenas. The success of this trade is due in no small measure to the anomaly of the tariff which taxes heavily many articles of first

necessity, but admits free of duty luxuries such as silks and perfumes. Many German houses are offering up to 180 days' credit as against the usual 90 days', but even with this inducement British goods remain popular, and, other things being equal, are preferred. Competition is, however, keenest from the Chilean manufacturers in the north, who, protected by the tariff, are increasing their exports to the territory. The value of imports from the north is about twice the total imports from foreign countries. In boots, shoes, and leather goods, fresh and tinned fruits, flour, wines and spirits, aerated waters, tinned milk and dairy products, they have practically captured the Magellan market.

Punta Arenas is not a quality market: quality-seekers buy direct from London or Paris, and the local warehouses cater more for classes for whom price is the predominant factor. The larger sheep farming companies, the freezers and the shipping companies, buy stores in Europe through their London agents, a list of whom may be had on application to the Department of Overseas Trade. Complaints are still occasionally received of the faulty packing of goods received at Punta Arenas. It should be rembered that, as at many west coast ports, there is no wharfage accommodation at this port, and merchandise is unloaded into hulks or lighters, to be brought ashore. Packing cases should be stoutly made, preferably with iron or steel bands. Weights should be stencilled on the outside in kilogrammes, and all directions as to handling, etc., should be clearly marked in Spanish as well as English.

Although competition, especially in hardware and textiles, is very keen, money is circulating better than it has been doing for some years. Drafts are being met better, and the outlook for the immediate future is brighter than it has been since the slump of 1920.

Activity has been shown during the past year in the construction and maintenance of roads in the territory. The majority of the roads are in reality only bullock tracks which often in winter are not possible for motor traffic. A new metalled road is in process of construction between Punta Arenas and Natales, nearly 200 miles long. This road is laid entirely in Chilean territory, and will be a great improvement on the present track which at one sector runs into Argentine terrain. With the development of roads in the territory the market for motor vehicles, which is at present an American monopoly, may soon be worth the attention of British manufacturers.

Marble.—The formation of a company in Santiago with a capital of 4,000,000 pesos paper to work the white and coloured marble deposits in Cambridge Island—latitude 51° 23′ S., longitude 75° 02′ W.—has attracted attention. These deposits, forming cliffs running down to the sea in natural deep-water harbours, are within 35 miles of the ordinary routes of transatlantic steamers travelling via the Straits of Magellan, and as these boats are generally carrying very little cargo, it is hoped that export to Europe will thereby become possible. Abundant water is available. The marble is claimed to be of Carrerras quality, and it is estimated that it can be landed at Buenos Aires for 305 pesos paper per cubic metre, as against 730 pesos for Italian marble. There is no doubt that if the expectations are realized the new industry will give a decided fillip to the coasting trade. It is to be remarked that as the chief markets for the marble will probably be Buenos Aires and Rio de Janeiro, the shipping traffic will not necessarily be confined to Chilean companies.

Petroleum and Gold.—There is little doubt that petroleum exists in the territory, but so far no source where it exists in workable quantities has been found. Gold mining and dredging is, and has been for some years, at a complete standstill. There is little prospect of a revival in this industry in the immediate future.

Legislation.—The territory has been scarcely affected by the political troubles in the north, though the increasing output of legislation, which adds to the difficulties of business procedure, is not viewed favourably. There has been strong agitation for the abolition of the customs regime and of the Ley de Cabotaje (Coasting Law) in so far as it affects Magallanes, and a memorial to this effect has been presented to the central government. The cause of the agitation is the ever-increasing cost of living, which is now about 165 per cent. above pre-war level; only meat and vegetables among first necessities are produced in Magallanes, and the high freights and customs duties makes the price of other food and clothing very high. Should the central government decide to abolish the tariff, a splendid opportunity will be offered to British exporters to regain markets which were lost some years ago. At present the principal articles on which there is duty are: bran, mineral waters, garlic, alcohol, starch, peas, playing cards, beer, cigars, cigarettes, boots, shoes and leather goods, brooms, macaroni, beans, fruits, biscuits, flour, milk, vegetables, wood, maize, butter, potatoes, forage, cheese, salt, tobacco, vinegar, wine, pickles, jam and fats.

The administration of the territory is good, and in all undertakings there is a distinct progressive spirit which is handicapped by lack of financial means. Relations between capital and labour remain good.

THE CRUDE AMBER INDUSTRY OF GERMANY.

While there are deposits of amber in the Nordic countries and in Rumania, Sicily, and Spain, Germany possesses the most commercially profitable deposits in the world.

This branch of German industry produces raw or crude amber chiefly, marketing it to refiners for the manufacture of smoker's articles and amber ornaments. Surface deposits occur above Koenigsberg in East Prussia on the so-called Samland coast on the Baltic Sea. Two coastal villages, Palmnicken and Kraxtepellen, lead in production.

According to data collated by the United States Bureau of Foreign and Domestic Commerce, the German amber industry was acquired by the Prussian State in 1899. Since 1924 it has been operated by a company, which is the sole producer at present.

The pre-war production of crude amber from surface "blue earth" on the Samland coast amounted to about 400 metric tons annually. During the war it dropped to only one-fifth of this amount. Since 1922 pre-war production has been bettered. Installation of modern mining apparatus on the Palmnicken deposits permitted a production of 442 metric tons in 1924 and a production of 497 tons in 1925.

The crude amber which does not enter the market directly is processed by smelting and briquetting to pressed amber. Furthermore, amber smelting yields, as commercial by-products, succinic acid and oil of amber (oleum succini) used by the paint and chemical industries. In the period from 1913 to 1925 the production of smelted amber amounted to 1,572 tons; oil of amber, 526 tons; and succinic acid, 55 tons.

In March, 1926, Germany's leading amber-goods factories merged in a new manufacturing company, which will produce its finished wares in direct co-operation with the State amber works.

The sales of amber both in domestic and foreign markets amounted in 1925 to 40 metric tons of crude amber, 9 tons of pressed amber, and 203 tons of smelted amber.

The Free State of Danzig is the chief purchaser of East Prussian crude amber, Danzig having a number of important finishers of this material.

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NOTICE.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE PRODUCTION AND MEASUREMENT OF HIGH VACUA.

By G. W. C. Kaye, O.B.E., M.A., D.Sc.,
Superintendent of the Physics Department, The National Physical Laboratory.

Lecture I.—*Delivered February 15th*, 1926.

Early Pumps.

It was in 1643 that Galileo's assistant Torricelli discovered the possibility of producing a vacuum above the top of a mercury column by filling with mercury a tube closed at one end and more than 30 inches long and then inverting it into a reservoir of mercury. The first mechanical air pump is attributed to Otto von Guericke (1650), who attained pressures of about 1/1000 of an atmosphere and became famous for his experiment with the "Magdeburg" hemispheres.

The Florentine Academicians, who experimented on the properties of vacuous space, used as a pump a Torricellian tube suitably enlarged at its upper end into a reservoir closed by a luted-on cover.

For many years the Torricellian method maintained its supremacy as a means of producing a high vacuum and, as late as the closing years of the 18th century, we read of Count Rumford using the method in his researches upon the propagation of heat. He employed hot recently-boiled mercury and sealed off his experimental bulb before the blowpipe, just as we seal off electric lamps to-day. From the beginning of the 18th century to the middle of the 19th century the designing and construction of mercury pumps and the properties of vacuous spaces excited great interest in Germany, France and this country.

Most, though not all, of the pumps to which attention was given were of the barometric type. They are fully described in a lecture entitled, "The Development of the Mercurial Air Pump," given before the Royal Society of Arts in 1887 (Vol. 36, p. 20), by the late Prof. Silvanus Thompson. Geissler of Bonn in 1855 devised the pump which he used for exhausting vacuum tubes. Many other types of mercury pumps were designed about this time, the outstanding examples being two, one due to Töpler of Dresden (1862) and the other a few years later to Sprengel (1865). Töpler and Sprengel pumps were used by all the X-ray pioneers and, until a few years ago, were largely employed in the manufacture of electric lamps. The pumps are capable of yielding pressures of the order of 10^{-4} mm., but they are so slow that nowadays they are only used for special purposes.

PRESENT STATE OF THE ART.

Before considering present-day high-vacuum technique we may stop to consider what has been achieved so far with our most efficient means of obtaining high vacua. It is difficult to say what the highest attainable vacuum is, as all our measuring devices ultimately cease to operate. We shall, however, be safe in assuming that the highest measured vacuum is of the order of 10^{-8} mm. (about 10^{-11} atmosphere). Values of 10^{-9} mm. and less may be taken as belonging to an unmeasured region.

Now air at normal temperature and pressure contains something like 3×10^{19} molecules per cubic centimetre, so that at 10^{-8}mm. there are still left about 1,000 million molecules per c.c.

The mean free path, or the average distance traversed by a molecule between successive collisions with other gas molecules is about 10^{-5}cm. at atmospheric pressure in the case of air, oxygen, nitrogen, CO., and water vapour (hydrogen 2×10^{-5}cm., helium 3×10^{-5}cm.). Now from the kinetic theory of gases the mean free path is inversely proportional to the pressure, so that the mean free path for air at 10^{-2}mm. pressure is about 7mm., while at 10^{-8}mm. it is about 7 kilometres or, say, 5 miles. These facts are of importance, as we shall see presently.

The art of high vacuum production, which began to make strides at the beginning of this century, has been revolutionized within the last 10 years. The conspicuous advances are the use of liquid air and charcoal (1904), a method due, as is well known, to the late Sir James Dewar; the devising of the molecular pump by Gaede in 1913; and the invention in 1915 of the mercury-vapour diffusion pump by Gaede, of which Langmuir's condensation pump (1916) may be regarded as an independently developed and valuable modification. To these perhaps should be added the use of "getters," i.e., materials which, when heated, have the faculty of "cleaning up" the normal gas residues in a roughly exhausted vessel. Getters are of great commercial importance.

Most of these methods only assume practical value when the gas pressure is substantially reduced by some form of auxiliary or backing pump which runs in series with the high vacuum pump. The limiting vacuum attainable by most of the several methods depends in part on the ability of the backing pump to keep step with the vacuum pump. Theoretically, however, there is no limit to the degree of rarefaction attainable with mercury-vapour pumps, but in practice (as with all pumps) the pressure achieved is an equilibrium pressure determined by the rate of supply of gas and vapour from the walls and other parts of the vessel and connecting tubing, and the rate at which the gas is removed. The highest vacua will not be attained unless the arrangements are such that not only the vessel but the whole of the connecting tubing right up to the pump can be heated and "outgassed." If mercury vapour is present it must be frozen out or absorbed by the use of a suitable trap, if the highest vacua are desired.

Importance of Wide Connecting Tubing.

The speed of high-speed pumps is usually restricted by the connecting tubing, which accordingly should everywhere be kept as short and direct as possible and of as wide a bore as is practicable. Fig. 1 shows a discharge

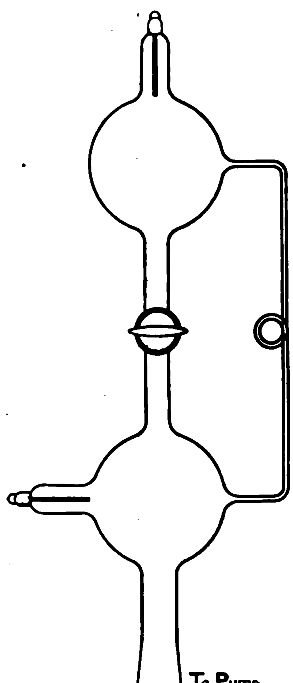

Fig. 1.

apparatus consisting of two glass bulbs connected by two paths :—(*a*) a length of 5mm. tubing, and (*b*) a short length of 20mm. tubing provided with a large tap. If one of the bulbs is joined to a high-speed pump and the wide tubing is closed by the tap, the marked disparity in pressure between the two bulbs and the delay in establishing equality are clearly shown by the electric discharge. The difference disappears at once if the wide tubing is brought into action by opening the tap. A diameter of 2cm. should be regarded as a practical minimum for connecting tubing if the advantages of a high-speed pump are to be fully realised.

These remarks apply equally forcibly to any glass taps which may be in the high-vacuum system. Many workers use taps which are far too small. Large glass taps of good quality can now be obtained having bores up to 25mm. in diameter. Again, constrictions in the vacuum system should be avoided whenever possible.

Gases Contained in Glass and Metals.

The gradual deterioration with time of the vacuum within vessels where leakage appeared to be ruled out has long been known, for example, in the vacua of carefully prepared barometers. It came to be suspected that the deterioration was brought about by the slow release of gas from the walls of the vessel. We now know that there are two distinct sources of such gas—" absorbed gas " throughout the material and " adsorbed gas " on the surface. In neither case does chemical cleaning assist in removing the gas.

As regards absorbed gas, the methods of manufacture of glass and many metals involve liquefaction, a process that results in the presence of large quantities of dissolved gases throughout the mass of the solidified material. These gases were prevented from escaping by the viscosity and surface tension of the liquid before solidification set in. The amount of gas so absorbed can be reduced by substantially raising the temperature of the molten material during manufacture, and so increasing the limpidity and the ease with which the gas is expelled. If the expense is warranted, heating in a vacuum furnace is very efficacious.

Glass and metals also readily take up and hold gases in the form of an adsorbed surface-layer only a few molecules thick. The adsorbed gases are held very tenaciously in ordinary circumstances, but are readily removed by moderate heating in vacua or by bombardment of the surface with an electric discharge.

These absorbed and adsorbed gases are slowly given off in the cold by glass and metals when they are exposed to a vacuum. The gases released from glass are largely water vapour and carbon dioxide, while hydrogen and carbon monoxide are the chief gases emitted by metals.

GASES IN GLASS.

It is of interest to follow the progress of events when glass is heated in vacuo and the temperature is gradually raised. In the case of soda or lead glass the adsorbed layer is liberated at about 200°C. ; (with boro-silicate glass at about 300°C.). The rate of evolution of gas then falls off somewhat, but the absorbed gas in the shallower layers is now also being released and the evolution of the absorbed gas begins to increase rapidly from about 400°C. up to the softening point of the glass, deeper and deeper layers giving up their gas. This is well illustrated by Fig. 2 which is based

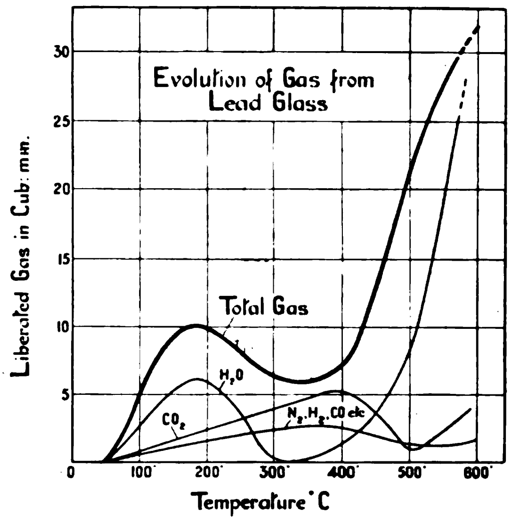

FIG. 2. Evolution of Gas from Lead Glass.

on Sherwood's figures for lead glass 350 sq. cms. in area (Phys. Rev., 1918). As will be seen, the greater part of the adsorbed gas is water vapour, a remark that applies also to the absorbed gas evolved near the softening point. At higher temperatures the evolution of water vapour continues indefinitely, being apparently due to chemical decomposition of the glass.

To obtain a high vacuum in a glass apparatus, it is necessary while pumping to heat both apparatus and connecting tubes to the highest temperature they will stand without the walls collapsing. This temperature is about 400°C. in the case of lead glass. The corresponding temperature for soda glass is about 500°C., for pyrex glass about 700°C. The heating can be carried out by means of a gas flame or electric heater. In the case of X-ray tubes and large wireless valves, this heating is prolonged into a thorough baking, an electric oven being lowered over the apparatus while the evacuation is in progress. In special cases a vacuum furnace is used and

enables the glass to be heated for some time above the softening point without collapse.

GASES IN METALS.

The property which many molten metals have of dissolving gas is well known, e.g., molten silver takes up large quantities of oxygen, some of which is expelled violently at the freezing point. Most solid metals in consequence contain surprisingly large quantities of gas. In some instances the volume of gas measured at N.T.P. may amount to several times the volume of the metal.

To free metal parts from gas they must be heated in vacuo to near their melting point for several hours or, at any rate, to temperatures well in excess of those at which they will operate. The " outgassing " of lamp filaments, for instance, is straightforward, while apparatus such as X-ray targets, valve grids and plates may be heated up either by direct bombardment or by exciting high-frequency eddy currents in the metal by coils surrounding the apparatus.

A useful expedient and one generally adopted is to submit the metals to previous vacuum heating before introducing them into the apparatus. Many metals so heated can be left for two or three days in air without re-absorbing an appreciable amount of gas. Some metals, for example, copper, if slightly oxidised, are apt to be troublesome as regards the giving up of their gas in vacuo. An analysis of the gas expelled from the copper anode of a Coolidge radiator X-ray tube disclosed over 90% of CO., the rest being mainly CO_2.

REMOVAL OF GREASE.

Next to the question of gas liberation from the walls and contained parts comes that of getting rid of grease. The prejudicial effect of grease on the attainment of really high vacua is now clearly recognised. Gaede found that in a particular case the ultimate pressure attainable by his molecular pump was reduced from 10^{-5} mm. to about 10^{-6} mm. when a greased ground-joint was replaced by a cement joint.

Clean dry tissue paper is often useful for assisting in removing grease from silica and glass ware, where the apparatus permits its use. The interior of glass-work can be rendered grease free either by the use of a mixture of potassium bi-chromate and sulphuric acid or, even better, by adding in situ a few drops of methylated spirit to strong nitric acid. The latter reaction starts steadily in the cold but increases in vigour as the mixture warms up. The resulting copious evolution of nitrous fumes is of particular value when cleaning intricate apparatus or capillary tubes. In either case the treatment should be followed by washing first with hot water and then with acetone, afterwards thoroughly drying out either by repeated evacua-

tion (by means of a rough pump), or by passing warm dry air through the apparatus, for which purpose an electric shampoo blower is very convenient. Metal parts are best freed from grease by washing in solvents such as ether or benzene, and then warming.

In the case of apparatus which is subjected to the heat treatment necessary for the production of a high vacuum, any grease present is vaporized off and is best removed by freezing out with a liquid air trap. If it is desired to keep the main liquid air trap uncontaminated by grease, provision may be made in the shape of a subsidiary liquid air trap which can later be sealed off, if desired.

Vapour Traps.

As already mentioned, if the highest vacua are to be attained, provision must be made for the removal of every trace of vapour. In this connection it may be noted that at room temperature the vapour pressure of water is about 15mm., of mercury about 0.001mm., of vacuum pump oils from about 0.001 to 0.0001 mm. Greases such as are used for taps and ground joints have even smaller values. It must not be forgotten also that all the various pumps, with the exception of the molecular pump, introduce either oil or mercury vapour. The molecular pump is, however, somewhat costly. Even the diffusion pump, which deals with vapours very readily, leaves a trace of mercury vapour which, though it may represent much less than the vapour pressure of mercury at the temperature of the apparatus, is nevertheless prejudicial for certain purposes, e.g., for heated tungsten filaments.

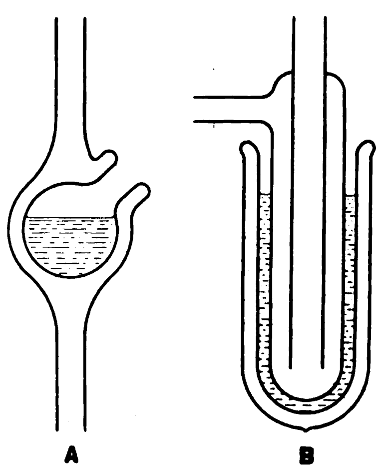

Fig. 3. Vapour Traps.

The usual way of effectively removing this mercury vapour, together with condensible gases and more volatile vapours such as oil and water, is to cool some convenient part of the apparatus to liquid-air temperature (—183°C.). Fig. 3 shows two designs of trap which are commonly employed for the purpose.

POTASSIUM TRAPS.

In those cases where it is difficult to get supplies of liquid air or where it is required continuously over long periods, traps of sodium or potassium metal are recommended by Hughes and Poindexter (Phil. Mag. Aug., 1925) as being as efficient as liquid air in arresting mercury vapour. The metal is distilled and condensed in a thin film on the inside of a connecting tube either T shaped or in the customary shape of a liquid-air trap. Hughes and Poindexter state that potassium will act as a mercury-vapour barrier until it has absorbed more than its own weight of mercury—a process which would take weeks in ordinary circumstances. Moderate exposure to air does not impair the potassium as a mercury-vapour absorber. The vapour pressure of potassium at room temperature is probably less than 10^{-8} mm.

Hughes and Poindexter describe the following technique of preparation :- About 4 ozs. of clean potassium is heated in the pyrex glass tube A (Fig. 4)

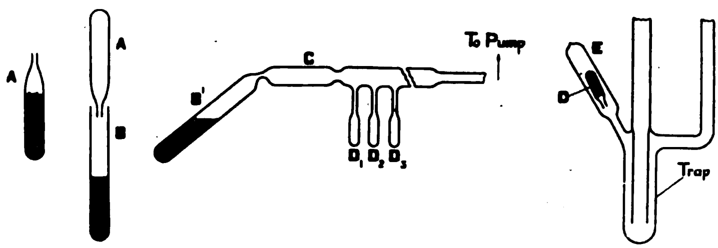

FIG. 4. Preparation of Potassium Trap.

by a Bunsen flame to drive off the hydrocarbons from the oil in which the metal is customarily stored. These burn at the mouth of the tube. When the metal itself begins to distil, it is decanted into another pyrex tube B where it solidifies, most of the oxide, etc. being left behind in A. The tube B is then sealed on to a pumping system in the position B′. The potassium is heated until the large evolution of gas virtually ceases, B′ acting as a reflux condenser meanwhile. Finally, the whole of B′ is heated, the metal is driven into C and B′ is sealed off. Next the potassium is liquefied in C and, by tilting the apparatus, the series of small containers D_1, D_2, etc., are each filled and sealed off in turn. When it is required to line the interior of a trap, one of these containers is opened and inserted mouth downwards into an annexe E. The latter is then sealed up and, as soon as a

good vacuum is obtained, the potassium is heated and runs into the trap where, by further heating, it is vapourised and distributed over the walls.

It must be borne in mind that alkali-metal traps are not capable of dealing with vapours other than mercury which are likely to occur in vacuum work. Provision may therefore have to be made for these during the baking of glass work, for instance.

LEAKS.

Where practicable the simplest method of detecting leaks is to raise the internal pressure of the apparatus while immersed in water and watch for air bubbles just as one does in examining a leaky inner tube of a tyre. Small leaks may only reveal themselves if the immersion is prolonged for, say, half an hour, and the method fails altogether for very small leaks.

A useful test in the case of glass apparatus is to send an electric discharge through the apparatus at a pressure when the pink positive column predominates. A swab soaked in petrol passed along the outer surface of the apparatus will, as it passes over the region of the leak, alter the colour of the adjacent discharge to blue. The possibility of contamination must be born in mind.

Alternatively, where it is not convenient to pass a discharge through the glass apparatus to be tested, a small insulated external electrode connected to a Tesla coil (with one end earthed) may be passed over the suspected parts. The leak may then show itself as a bright spot where the high-frequency discharge finds its way into the evacuated system.

In the case of either glass or metal apparatus, where the rate of rise of pressure can be followed by means of a vacuum gauge, leaks may be located by applying an external vacuum in turn to different parts of the apparatus and noting if and when the rise of pressure is checked. The method is of particular value for built-up apparatus which cannot be subjected to a thorough outgassing process and where it is desired to establish that a rise in pressure is due not to leakage but to the emission of occluded gas, as, for example, metal liquid-air containers (see the Oxygen Research Committee's Report, 1923). In the case of apparatus the outgassing of which has been reasonably complete, the two effects are not likely to be confused in practice, as any leakage effect is normally much larger.

If the apparatus is being exhausted by a rapid pump capable of handling vapours, e.g., a mercury-vapour pump, a useful method is to note the lowest pressure attainable and then to observe the effect of applying sealing wax or collodion solution to suspected places. A fall in pressure indicates that the leak has been located. For some purposes, however, the resulting slight contamination of the vacuum system may be objectionable.

For cleanliness and sureness the simple expedient of smearing the suspected area with water is preferable to all others, provided a liquid-air trap is included in the vacuum system. In this case the location of the leak will be accompanied by a marked fall of pressure, since, although the leakage continues, water vapour now enters in place of air, and this vapour is arrested by the liquid air trap.

Metals occasionally give rise to very insidious troubles. For example, a hair crack pursuing a meandering path, and passing en route through a blow-hole, may give endless trouble by reason of the lag in response to a change in the pressure. Electroplating will sometimes seal up pin-holes of this kind. Porous brass can be remedied by tinning. It is possible that the Schoop metal spraying process might also afford a cure. Sealing wax, which is often employed, should be used with caution.

METAL TO GLASS JOINTS.

The prime essential in metal to glass joints is that the two co-efficients of expansion shall be in close agreement over the temperature range employed, or that by suitable design any stress due to unequal contraction shall be so accommodated that in the end it does not exceed the mechanical strength which it is possible to give the metal to glass union.

The table gives the average expansion co-efficients of a number of materials, together with the melting or softening temperature.

Material.	Expansion coefficient per °C.	Melting or softening temperature.
Tungsten	4×10^{-6}	3350°C.
Molybdenum	5	2550
Platinum	9	1755
Steel	10.5	1530
Nickel	13	1452
Copper	18	1083
Lead	28	327
Vitreous silica	0.5	1700
Pyrex glass	3	800
Porcelain	3	1100–1400
Soda glass	8.5	550
Lead glass	9	500

Until 10 or 15 years ago platinum was the only readily available metal, the expansion co-efficient of which approximated to that of soda or lead

glass, i.e., about 9×10^{-6} per degree C. Most other metals have appreciably greater co-efficients. Consequently, platinum was universally used, for example, for the sealing-in wires of electric lamps. Its enormous increase in price, however, made it necessary to cast about for substitutes for commercial purposes.

COPPER TO GLASS JOINTS.

It has long been known that, despite the disparity in the expansion co-efficients, one might occasionally succeed in sealing fine copper wire directly into glass. Presently it was discovered that the chances of success were raised by flattening the wire and so increasing the surface of contact. Housekeeper, of the Western Electric Company (Journ. Amer. Inst. Elect. Eng., 1923) investigated the matter and found that molten glass wets copper just as water wets glass. The adhesion on cooling is so strong that any subsequent fracture will normally occur within the glass itself and not at the joint. If the design is such that either the glass or the copper can accommodate itself to the stresses set up, then fracture may be avoided. Such accommodation is not possible when both materials are thick, but only when one or the other is sufficiently thin.

Housekeeper found that for copper to glass joints the most successful form of " lead-in " was feather-edged tape or ribbon inside a flat "pinch" seal, the glass round the tape being everywhere sufficiently thin to afford the necessary accommodation.

In the same way copper tubing may be joined to glass tubing. The end of the copper tube is turned down to a feather edge so as to give a good fitting taper joint with the glass tube, the overlap being not more than a few mms. The glass may be either on the inside or the outside of the copper. In much the same way a thin copper disc can be sealed facewise over the flared end of a piece of glass tubing. It is advantageous to seal a ring of glass to the other face of the disc, care being taken that the glass does not spread over the edge of the disc. If a copper rod or wire is passed at right angles through the centre of the disc we have a suitable seal for a heavy-current lead into an evacuated vessel. (Fig. 5.)

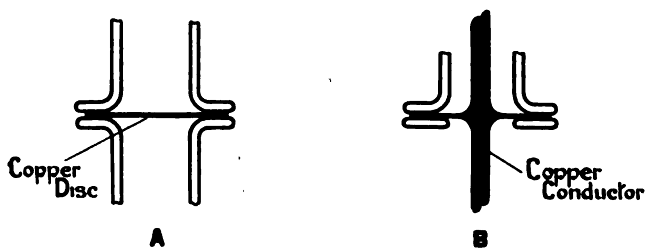

FIG. 5. Copper to Glass Disc Seals.

A successful technique with copper-glass joints consists in heating in the copper in an oxidizing blowpipe flame, until it assumes a coating of black oxide. It is then dipped into a saturated solution of borax and re-heated in the flame, the process being repeated if necessary until a thin film of the salt spreads over the metal and combines with the oxide to give a ruby-red copper borate. The glass will readily adhere to the copper under these conditions when the two are heated in the blowpipe flame. The joint should not be more than a few millimetres wide and should everywhere show the brilliant red colour of copper borate.

NICKEL-IRON TO GLASS JOINTS.

For most purposes, however, copper is nowadays replaced by an alloy with an expansion co-efficient approximating to that of the glass. Such a material makes less demand on the mechanical strength of the joint and so the design becomes less important.

Now Guillaume showed some years ago that, in the case of alloys of nickel and iron, the expansion co-efficient varied in a remarkable way as the proportions were varied. The table shows some of the expansion co-efficients :—

NICKEL-IRON ALLOY.

Percentage of Nickel.	Expansion Co-efficient per °C. at room temperature.
10%	13.0×10^{-6}
20	19.5
30	12.0
36	0.9
40	6.0
50	9.7
80	12.5

The 36% alloy is the well-known invar. Its expansion co-efficient is very sensitive to the composition.

We see that an alloy containing 50% or a little less of nickel has a co-efficient approximating to that of lead or soda glass, and this alloy is very largely used for glass-to-metal joints. It is coated with a thin layer of copper (about 1/1,000 inch thick), and the procedure of making a glass-to-metal joint is as already described in the case of copper.

In the case of tube joints the alloy may advantageously be thinned down near the glass joint, but not to the extent necessary with copper. Either external or internal joints may be effected depending on the expansion

co-efficient, but for large diameters, as with high-power glass-metal valves, the external type of joint is preferred, i.e., with the glass outside the alloy. There appears to be no practical limit to the diameter of the tubing with which joints may be effected.

For the sealing-in wires of electric lamps and small valves, the nickel-iron alloy has too high an electrical resistance to be suitable for the purpose. Accordingly, wire is made of the less expansible 40% alloy and coated with a substantial layer of copper amounting to some 20% of the cross section. The overall expansion of the composite "dumet" wire is of the right order, and the copper provides the necessary conductivity as well as the basis of the glass seal. The red colour of the cuprous oxide in the joint is responsible for the name "red platinum" given to this composite wire in the trade.

As regards the use of the nickel alloy for inserting, say, copper electrodes into glass, this is effected by using a flared collar or thimble of the alloy which just threads over the copper terminal. The copper-to-alloy joint is then completed by soldering or brazing.

Chrome-iron to Glass Joints.

Reference should also be made to the chrome-iron alloy originated and used by Philips Lamps, Ltd., for metal-to-glass joints. This alloy, consisting of about 75% iron and 25% chromium, has an average expansion co-efficient of about 10×10^{-6} per °C., a figure which approximates closely to that of glass. Stainless steel, which it will be recalled has a composition of about 85% iron and 15% chromium, has a somewhat higher expansibility. Its rustless qualities are not shared by the 25% chromium alloy which, however, is wetted by molten glass and so permits direct glass-to-metal joints to be made without the intermediary of copper plating.

To effect a joint the alloy is first slightly oxidized by heating in an oxidizing flame (an oxy-coal gas flame is suitable), a "thread" of glass is melted on to the edge of the metal at the proposed line of junction, and the joint is completed by fusing this to the glass component. The edge of the alloy is usually tapered off a little. The overlap is not more than 1 or 2 mms. wide. The alloy, which is a little harder than mild steel, has a low heat conductivity and can be heated without injury to 1,000°C.

Its expansion co-efficient should exceed slightly that of the glass by an amount within the limits 0.5×10^{-6} to 0.9×10^{-6}. Otherwise it is found that the joint, whether internal or external, is apt to fail eventually.

Platinised Metal to Glass Joints.

In experimental work it is still occasionally convenient to make use of one of the oldest methods of effecting a metal to glass tube joint, that is,

through the intermediary of a platinum deposit. This is best effected by means of a colloidal solution of platinum in lavender or other essential oil*—a method which has been known for some 60 or 70 years.† The solution is painted on the glass and, when suitably heated in a Bunsen flame, deposits a mirror of platinum. This is then copper-plated and the joint to the metal tube is completed by soldering. Cailletet in his work on the liquefaction of gases 40 years ago found that such a joint withstood 300 atmospheres internal pressure. In practice it is advantageous to roughen the glass tube before platinising and afterwards to copper and nickel plate alternately. The method works equally well with vitreous silica.

METAL TO SILICA JOINTS.

Vitreous silica is now used for certain forms of vacuum vessels, notably high power valves, mercury-vapour lamps and mercury-vapour pumps. Through the co-operation of Messrs. Mullard and H.M. Signals School at Portsmouth, this country has assumed a notable lead in the manufacture of high-power silica valves up to 30 k.w. capacity. Clear silica should be used as the translucent kind is apt to be porous. Clean molten lead posseses the property of wetting silica and is much used for sealing tungsten or molybdenum electrodes into silica. The lead is contained in a tapering pocket round the rod. The technique which is due to Sands (Proc. Phys.

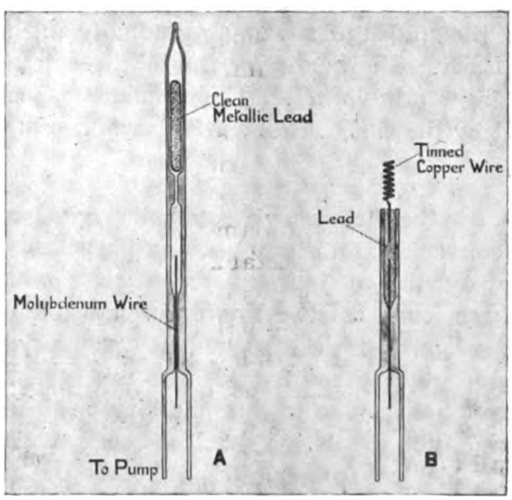

FIG. 6. Sands' Lead to Silica Seal.

* For example, "liquid platinum" sold by Messrs. Johnson Matthey & Co.

† See a paper on "Glass to Metal Joints," by McKelvy & Taylor. Journ. Amer. Chem. Soc., 1920.

Soc., 1914) is as follows. In a silica tube shaped as shown in Fig. 6A is placed a molybdenum wire fitting easily into the capillary portion and a piece of clean lead in the reservoir above, the upper end being then sealed off. The end below the capillary is joined to the pump and the tube is exhausted. The silica round the capillary is then softened and pinched or collapsed on to the molybdenum wire. The lead is now melted and allowed to trickle into the tapering space below, which has also been heated. The upper end of the tube is then opened to the air while the lead is still molten, so that the atmospheric pressure forces it well against the interior wall of the silica reservoir. The tube is finally cut as shown and a tinned leading-in wire inserted into the lead. (Fig. 6B).

SILICA TO GLASS JOINTS.

It sometimes happens that it is desirable to construct certain parts of an apparatus of pyrex or vitreous silica, while it is convenient to use lead-glass for the remainder. In such a case a method of effecting the junction is to join the lead-glass to a hard glass through several special glasses in diminishing order of expansion co-efficients. The hard glass is joined to pyrex and, if a further joint to silica is required, the free end of the pyrex is heated in the blowpipe flame until it has lost sufficient boric oxide to enable it to weld to silica. While the several intermediate glasses differ in composition, melting points and expansion co-efficients, they must be so completely fused with one another that each largely loses its identity, the properties of the graded joint varying gradually and continuously from one end to the other. The quality of the joints may be checked by the use of a polarising strain-viewer. The technique of such joints has been largely developed by the G.E.C. Research Laboratories at Wembley.

GROUND JOINTS.

Ground joints, whether between glass and glass, glass and metal or metal and metal, are convenient for many vacuum purposes. At the National Physical Laboratory steel-to-steel and steel-to-glass joints up to 2½ inches diameter have been found trustworthy and practicable for vacuum work. The merest trace of grease is necessary unless a mercury seal is used, when the grease should not be present. Oil seals are best avoided, owing to the slight 'leakage' effect due to the solubility of air in the oil. In the case of a discharge tube the design should be such that, if a ground joint is present, it is shielded from electrical bombardment—otherwise the joint may crack. Furthermore, gas will be evolved continually from the grease.

METAL TO METAL JOINTS.

Cast metals, whether iron, brass or aluminium, are rarely suitable for vacuum containers, being nearly always porous. Faulty brass and iron

castings can be cured by tinning or stove-enamelling either surface. Copper and good quality mild steel are usually trustworthy. If tubing is used it should be seamless.

As regards metal to metal joints, if soft soldering is utilised it requires to be carefully done to be effective. If brazing is possible it is usually preferable. A steel to steel union may be effected by oxy-acetylene welding. Great care must be taken to avoid burning the metal and so making it porous. Nickel plating is sometimes useful as a cure in such cases. Further, the design must be such that at the junction the two portions to be joined are relatively thin and not very dissimilar in mass, otherwise distortion will occur. Electric "spot-welding" has assumed great importance in the electric lamp and valve industry. No other method can approach it for speed and certainty in the welding of wire or ribbon of certain metals.

Cement Joints.

Much of the research work on low-pressure phenomena has depended in the past on the use of sealing wax for making joints, and even now the method is frequently employed in experimental work, though for some purposes wax is objectionable. The more volatile components of a wax are no doubt gradually removed from the interior surfaces where they are exposed to a reduced pressure. Sealing wax is precluded, of course, for joints which become heated or are electrically bombarded, nor should it be exposed to water, in view of the hygroscopic nature of the contained shellac. The tendency of a waxed joint to develop invisible cracks on standing should be remembered. Two of the best hard sealing waxes for vacuum work are Bank of England and Waterston's 'Bee' brand. Many workers prefer the softer vacuum waxes of beeswax, resin and rubber made up in three hardnesses by Mr. Everett, well-known for his long association with the Cavendish Laboratory. Khotinsky cement (shellac melted with pitch from Caroline tar) is widely used in the States for vacuum work, while Picein finds extensive application on the Continent.

Whatever the wax, the surfaces to which it is applied should be sufficiently hot to cause the wax to melt without boiling. It is often advantageous, in addition, to play over the surface of the waxed joint with a small non-luminous flame, such as may be obtained from a fine jet made by drawing out a piece of quill glass tubing. In some cases a solution of sealing wax in alcohol (not methylated spirit) may be applied to a joint where heating is undesirable. It is possible that Bakelite cement might also be useful in this connection.

Rubber Joints.

Rubber tubing is preferably not used for high-vacuum connections. If so used the tubing should be of large diameter, thick walled and of as

short a length as possible. The tubing should not be perished, but even when new it is liable to be porous and to emit gases and vapours. It should contain a minimum of sulphur. There is naturally not the same objection to employing rubber tubing in a rough vacuum system. Junctions with glass tubing may advantageously be painted with castor oil, collodion or sealing-wax solution. It is a good plan to clean out thoroughly the interior of rubber tubing before use.

OBITUARY.

MAJOR-GENERAL BERESFORD LOVETT, C.B., C.S.I.—By the death of Major-General Beresford Lovett on 12th September at his Guildford home at the age of 87, is removed one of the few surviving personalities whose Indian Service dated from mid-Victorian days. Born on 16th February, 1839, in Paris, where his father, the late Rev. Robert Lovett, was attached to the Marboeuf Chapel, he acquired an early command of both French and English and this bilingualism seems to have given him a facility for obtaining later on a mastery of Persian and other oriental languages. After passing through Addiscombe Military College, of which he was one of the last students before its closure after the Indian Mutiny, he entered the Royal Engineers in 1858 and in 1860 joined the newly established Public Works Department. This period in that Department was one of great activity, in which Lovett took his full share, building many bridges and other works connected with river engineering. From 1866 to 1870 he was engaged on constructing telegraph lines in Persia, and during the two following years was employed on a special mission to Seistan for delimiting the frontier, as a result of which he was awarded the C.S.I. In addition to his civil engineering work, Lovett served with distinction in several campaigns on the North-West frontier—in the Jowaki-Afridi Expedition of 1878, the Afghan war in 1878-79, when he received the brevet of Lieutenant-Colonel, and the Hazara campaign of 1888, when he was in command of the Royal Engineers and received the C.B. He became a Major-General in 1892, and retired from the service in 1894.

Major-General Lovett retained in retirement an active interest in engineering matters, especially in connection with India, and on various occasions took part in discussions on subjects connected with Indian irrigation and survey at the meetings of the Society's Indian Section.

NOTES ON BOOKS.

THE ECONOMIC DEVELOPMENT OF RUSSIA, 1905 to 1914. With special reference to Trade, Industry and Finance. By Margaret S. Miller. London: P. S. King and Son, Ltd. 12*s*. 6*d*. net..

Russia differs so much from any other state of the world as to make anything like a strictly comparative study hopeless, the four conditions—immensity, lack of communication, winter dead-lock, and scant sea-board—conspiring not only to make Russia unique, but also to make a study of its special history one of considerable importance.

No decade in the history of Russia is so important as that of which our author treats: excepting perhaps the period when the ambitious Sophia, after having done much towards securing the very desirable Crimea from the Tartars and the Turks, plotted against the youthful Peter; but happily with ultimate failure, owing to the genius of the intended victim.

On pages 8-9 the author tells us of the relatively small band of black soil which stretches in a north-easterly direction from the Dnieper to the Urals: this band furnishing food for Russia; also gold in exchange for exported grain. Apart from statistics, tabulated matters, references to authorities, and a carefully made index, a notable aspect of the work under notice is contained in Chapter II—The Sociological Basis of Economic Development, pages 15 to 36. Here we find a study of the activities of Marxian Socialists, who departed somewhat from the teachings of Karl Marx and formed various sects: Lenin (or Il'in) having been a prominent figure. The broad results confirm the view that collectivist socialism is inherently unstable by reason of its tendency to drift into something else; often into an uncontrolled autocracy.

With regard to the above-stated view as to drifting from a theoretically perfect socialism to an uncontrolled autocracy, it may be suggested that precautions advocated by the most cautious school of British Marxians appear to be of little avail when the head of a collectivist state assumes a position of absolute power. Full democracy may be the law in a formal sense, and this even to the extent of the initiative and referendum; but if the head of the state has all industrial and administrative machinery under his own influence the organisation for voting may be so meagre as to make voting difficult or impracticable; moreover a blow may fall on the head of him who first protests. Considerations of this kind raise the question whether a considerable, or even predominating, infusion of capitalism or private ownership is or is not an essential to social stability.

The work under notice deserves a place in the classics of special or sectional history.

THE ORIGIN AND EARLY HISTORY OF INSURANCE: INCLUDING THE CONTRACT OF BOTTOMRY. By C. F. Trenerry. London: P. S. King and Son, Ltd. 15s. net.

We have here an extensive collection of carefully taken notes with reference to sources and authorities: indeed, such matter as a student of high ability gathers together when searching through libraries, with a view to elucidating some special subject. Such surplus matter often includes far more irrevelant or collateral matter than that which is germane to the exact aspect or aim of search.

The author, the late Dr. C. F. Trenerry, who died in 1911, performed a self-imposed task with the thoroughness of the single-minded student, whose one aim is to arrive at historical truth or balance, and he appears to have collected materials with quite exceptional industry. A foreword by two editors shows that Dr. Trenerry had no intention of publishing the whole mass of matter, as now issued under a main title, which it is difficult to regard as strictly descriptive; and moreover without an index.

There is but little early history of insurance extant if we use the term insurance strictly, and this little could be well stated in much less than the 330 pages now before us. Our impression is that our author's original short, lucid, and exact thesis on the origin and history of Insurance, was duly published in magazine form and also printed separately.

Later, or present-day insurance, in Great Britain at least, seems to have arisen out of the fire of 1666; and in the reign of Queen Anne several offices commenced

active insurance operations, but questionable practices on both sides became so predominant that legislation against insurance was enacted. Since then insurance has tended towards becoming a contest or game of skill between two sides, and recent experiments on unemployment insurance appear to have stimulated this aspect, if we may judge from newspaper items and magazine articles. Insurance in relation to political economy and social well-being is considered fundamentally in the Bliss Encyclopedia of Social Reform, Ed. of 1897, pp. 735-742.

STEREOSCOPIC PHOTOGRAPHY. By Arthur W. Judge. London: Chapman and Hall, Ltd. 15*s*. net.

Since the publication of Brewster's pioneer treatise on the stereoscope seventy years ago, nothing comparable to the present volume as regards thoroughness and completeness has appeared in Great Britain, and such is the progress in stereoscopic matters as also in modes of illustration since 1856 that the remarkably full pictorial aspect of the work before us contracts strikingly with the pioneer volume of Brewster.

Not only does the author give us many actual examples of stereoscopic work but the 18 inset plates and the 148 illustrations in the text form in themselves a vivid pictorial record of 70 years' progress, both as regards results and apparatus. The last two of the illustrations in the text, Figs. 147 and 148, are of especial interest as showing the optical and mechanical principles involved in the method of stereoscopic projection on the screen due to Dupuis and Schmidt, other previous methods being explained and illustrated in the same chapter. Anderton's method by polarised light (pp. 230-231) is perhaps the most interesting of these from the scientific standpoint.

Aerial photography, which in its stereoscopic aspect gives us means for land survey from the skies, is considered and illustrated with notable care and thoroughness, p.p. 210-226. Among the numerous new applications of stereoscopy we may mention astronomy, pp. 194-199; x-ray work, p.p, 200-9; also range finding p.p. 140-144.

Pseudoscopic aspects and the various curious effects obtainable are explained in theory, and shown by many examples which (like others in this book), can be seen with a suitable viewing device or stereoscope held in the hand, pp. 82, 83, 84. It is not practicable to give a full list of the many subjects elucidated in the chapter on "Applications and Curiosities," but one may mention Mr. C. Behnam's concept and representation of the four dimensional cube or hyper-cube, p. 155 illustration and p. 157 text.

This work should at once take status as the standard British text-book of stereoscopy, and we may hope for edition upon edition.

GENERAL NOTE.

FOX FARMING IN ALSACE-LORRAINE.—Fox farming in Alsace-Lorraine is proving very successful, and interest in the industry is apparent in various parts of Europe, according to a report by the United States Consul at Strasbourg. Five farms are now being operated, all of them in the Vosges and Jura mountain ranges. A representative of the local company is authority for the statement that there is a great demand for foxes for use in the establishment of farms in Germany.

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CONTENTS:

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REGISTERED AS A NEWSPAPER.

: SOME CANTOR : AND OTHER LECTURES

Recently delivered before the Royal Society of Arts.

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The Inner Structure of Alloys. Three Lectures. By WALTER ROSENHAIN, D.Sc., F.R.S. (1925.) Price 2s.

Copies of the above lectures can be obtained from the Secretary Royal Society of Arts.

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FRIDAY, OCTOBER 1st, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

COMPETITION OF INDUSTRIAL DESIGNS.

LOCAL EXHIBITIONS.

As has been done in the two previous years, arrangements were made this year for holding exhibitions of particular sections of designs in provincial industrial centres after the close of the exhibition in London.

An exhibition of the designs for pottery and china has accordingly been held in the Burslem School of Art during September, and a similar exhibition of the glass designs was arranged by the Wordsley School of Art at Wordsley. The designs in the textile section will be exhibited at Leeds during October, under the auspices of the University of Leeds.

DOMINIONS AND COLONIES SECTION COMMITTEE.

The list of members of the Indian Section Committee is as follows:

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Major Sir Humphrey Leggett, R.E., D.S.O., Chairman of the Committee.
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W. Perry, B.A., Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE PRODUCTION AND MEASUREMENT OF HIGH VACUA.

By G. W. C. Kaye, O.B.E., M.A., D.Sc.,

Superintendent of the Physics Department, The National Physical Laboratory.

Lecture II.—*Delivered February 22nd*, 1926.

Backing Pumps.

As already remarked, the several high-speed vacuum processes which have been devised of recent years normally require to be "backed" by

a preliminary or fore pump which will effect an initial reduction in pressure. The extent of this "fore vacuum" depends on the nature of the high-vacuum pump and the requirements range from 20mm. to 1/100mm. with different types. Some form of mechanical oil pump is usually employed as a backing pump, though a water jet pump will suffice for the higher backing pressures.

Certain designs of mercury vapour pumps are so rapid that their action is stifled unless the backing pump is of large capacity. If such a backing pump is not available, the insertion of a large reservoir between the backing pump and high vacuum pump may be temporarily advantageous.

Oil Pumps.

The use of oil as an air-tight seal between moving parts of pumps is doubtless of long standing. Oil pumps are of two general types—piston and rotary, and their design has received much attention of late years. Either type will operate from atmospheric pressure, but they do not handle vapours satisfactorily because of the condensation which occurs during compression. Oils used in vacuum pumps should be as non-volatile as possible. Unfortunately, oil is a solvent of many vapours, including water with which it does not readily part. An oil pump should therefore be protected on both its inlet and outlet sides by suitable drying and vapour absorbing devices, otherwise its performance will fall off sadly with ordinary laboratory malpractices.

It should also be remembered that the solubility of air in oil is comparable with the solubility in water. The large evolution of air from oil when first put under reduced pressure can be readily demonstrated.

The "Geryk" Piston Oil Pump.

The "Geryk" pump, designed by Fleuss, utilises an oil sealed piston. Above it is a pool of oil which moves up and down with the piston and so provides a perfect seal for both the piston and its valve. As the piston approaches the top of the stroke, a spring-controlled valve in the head suddenly gives way under the pressure, and the entrapped gas and some of the oil are projected through the valve and the oil seal above it. The transported oil thus really functions as the piston and no difficulties arise from dead space in the cylinder head. The sudden release of the head valve is intended to assist in preventing the gas from sticking to the walls at low pressures; on the return stroke the head valve does not close until enough oil has run through to provide the oil seal for the piston.

The success of the pump depends on the oil being maintained free from dissolved moisture, vapours and air. A single cylinder pump in good condition will give pressures of the order of 1/20 to 1/50 mm.

Two-cylinder Geryk pumps are also constructed. They are connected in series if low pressure is the chief desideratum ; and connected in parallel if large volumes of gas have to be dealt with. The pumps may be either hand or motor driven.

A more elaborate " R.L." type of Geryk pump is also made. This is designed to overcome the difficulties arising from oil vapour. The performance claimed for this pump is 10^{-5}mm.

Gaede designed an oil piston pump in 1913 consisting of 4 pumps in series worked by a common piston rod in the same vertical cylinder. The performance of this pump when working from atmospheric pressure was stated to be 5×10^{-5}mm.

Gaede Rotary Oil Pump.

In Gaede's rotary oil pump a solid steel cylinder rotates within a large cylindrical casing of bronze, the two being in close contact at a point lying between an inlet and outlet port. Two vanes sliding within a diametral slot in the rotating cylinder are kept continually pressed by coiled springs against the inner wall of the casing which they scrape as they rotate with the cylinder. The effect is to pass ' parcels ' of air continually from the inlet port to the outlet port where a non-return metal valve is mounted. Sufficient oil is present to serve for lubrication, sealing and the filling up of any dead space. The pump will operate from atmospheric pressure, in which case it will produce a pressure of the order of 10^{-2}mm. If used with a fore pump capable of maintaining an initial pressure of a few millimetres, the vacuum attainable is about 10^{-3}mm.

Cenco Hyvac Rotary Oil Pump.

The Cenco Hyvac pump is another type of scraping-vane pump, but with this difference. The inlet and outlet ports are close together, being separated by a single vane which passes through the casing and is under pressure from a spring as shown. The cylinder rotates eccentrically about an axis which coincides with the centre of the casing. The entire pump is submerged in oil.

As made commercially, two of these units are mounted side by side at a slight angle to each other on a common horizontal shaft, the one unit acting as a backing pump to the other. A small leather valve closes the outlet port and a glass oil trap is provided at the inlet to prevent oil being sucked into the apparatus when the pump is stopped. The leather valve requires to be periodically renewed. In a later model the leather valve is replaced by a steel ball and the glass oil trap is replaced by a rectangular metal box built in with the casing of the oil tank.

The Hyvac pump will yield a pressure of about 10^{-3}mm. direct from atmospheric pressure. The pump, which is relatively quiet in action, has a speed at 0.25mm. of about 100 c.c. per sec. It is largely used as a backing pump for mercury-vapour pumps, but to operate with very high speed pumps its capacity should be considerably increased.

HIGH SPEED PUMPS.

Gaede Rotary Mercury Pump.

Gaede's rotary mercury pump marked a great advance in high vacuum pumps when it was originated in 1905 (Phy. Zeit. 6, 758, 1905), though it is now nearly obsolete.

The speed is stated by Gaede to vary between 100 and 150 cc/sec. for backing pressures ranging from 10mm. to 1/100mm. Such speeds are very low in the light of the performances of more recent types of pumps.

Gaede Molecular Pump.

The molecular pump of Gaede (Phy. Zeit. 13, 864, 1912) was the first of the high-speed pumps. Its action is based on the drag exerted on a gas by a rapidly moving solid surface. This may be realised by a cylinder rotating at high speed within a closely fitting stationary casing provided with an inlet and outlet port in the periphery. The gas in the peripheral clearance space is dragged by the rotating surface from the inlet to the outlet port. If the gas pressure is such that the mean free path of the gas molecules is not large compared with the clearance, the small *difference* of pressure established between inlet and outlet will depend on the peripheral speed, on the dimensions of the channel, and the viscosity of the gas. If, however, the pressure is reduced by a backing pump to 1/100mm. or so, the mean free path becomes of the order of several millimetres. This is much larger than the peripheral clearance, and so at such pressures collisions between molecules become few in comparison with collisions between molecules and the enclosing walls. In other words, the viscosity of the gas becomes unimportant.

Now the velocity of rebound of a gas molecule from a stationary surface is the same as that of impact. If, however, the surface is moving, the rebound velocity is altered, there being an increase in the component of the velocity of the molecule parallel to the moving surface to an extent depending on the speed of the surface. As every collision with the moving surface contributes motion to the molecule in the same direction, it is obviously desirable to have as many collisions as possible, and so the distance between the moving surface and the stationary surface is made as small as is practicable (about 1/10 mm.).

It comes about that when the pressure is low enough, the *ratio* of the inlet and outlet pressures depends simply on the peripheral speed of the

cylinder. The ratio begins to fall off when the pressure rises above that at which the clearance equals the mean free path. The pump will, however, still function, though less advantageously, at pressures as high as 20mm.

We thus see that, the lower the backing pressure and the greater the peripheral speed, the higher the degree of vacuum attainable. In practice it is found that a fore vacuum of about 1/100 mm. is best adapted to these pumps. Vapours are pumped as well as gases. In general the pressure attained is lower as the density of the gas increases. Gaede's molecular pump permits speeds up to 12,000 revolutions per minute. At this speed and with a fore-vacuum of 1/100mm., the attainable pressure is less than 10^{-6}mm. The curve of pumping speed reaches a maximum of about 1,400 cc./sec. at a pressure of 1/100mm. This falls to 1,300 cc./sec. if the pressure is reduced to 1/1,000mm., and to 1,200 cc./sec. if the pressure is raised to 1/10mm.

In Gaede's actual model the rotating cylinder was provided with a number of circumferential grooves of different depths, into which protruded from the casing a 'comb' with teeth which fitted closely within the grooves. Gaede's molecular pump has, however, been considerably developed and improved in constructional details by Holweck (Journ. de Phy. 1922), whose model we shall proceed to describe.

Holweck Molecular Pump.

The moving surface in the Holweck pump is a smooth cylinder of duralumin. This rotates within a closely fitting stationary bronze casing provided with a central inlet port, the clearance being not greater than 0.05mm. On either side of this port a helical groove is cut in the inner face of the casing. One helix is right-handed, the other left-handed, and the depth of the grooves gradually increases from about ½mm. at the ends to 5mm. or more at the central port where the two grooves unite. The two outer ends of the grooves communicate through a channel in the body of the casing to the outlet port, and so to the backing pump. For clearness the outlet port is shown to one side in Fig. 7 but it is really situated in the centre beside the inlet port. When the cylinder rotates in the correct direction the gas contained in the helical grooves is dragged from the centre of the casing to the two ends. Ball bearings are provided for the cylinder, which is maintained in rotation by an induction motor, the "squirrel-cage" rotor of which is on the cylinder shaft within an extension of the pump casing, the stator being outside. The material of the casing about the rotor is such as to minimise heating from eddy currents. A small rotary converter furnishes the two-phase alternating current which is supplied to the stator.

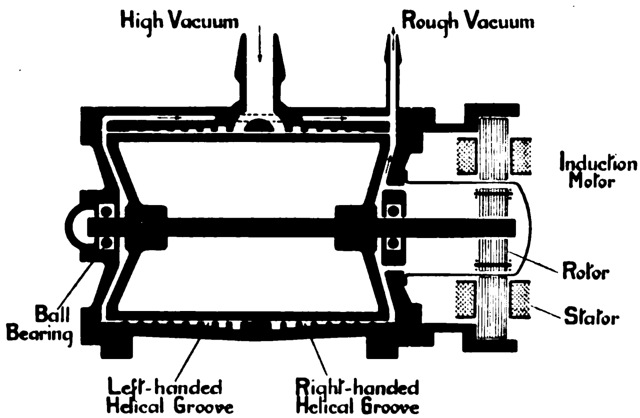

FIG. 7. Holweek Pump.

It will be seen that the interior of the ends of the pump casing, including that round the rotor, is subjected to backing pump pressure and this obviates any chance of leakage through the joints to the high vacuum portion of the pump. It is important that water or grease should not be allowed to find their way to the high-vacuum region of the pump.

In the case of the commercial model, the normal working speed of the cylinder is about 4,000 revolutions per minute and the pressure ratio is about 10^5, so that with a backing pressure of 1/10mm. a vacuum of the order of 10^{-6}mm. is possible. The speed of pumping under these conditions of backing may reach about 2,300 cc./sec. It may be added that in experimental models Holweck obtained a pressure ratio as high as 2×10^7.

The molecular pumps are inexpensive to run, will pump vapours and so do not need a vapour trap. On the other hand, they are somewhat noisy and costly and are liable to be attended by mechanical troubles inherent to the design.

MERCURY-VAPOUR PUMPS.

The pump which has displaced all others for most high vacuum work is the mercury-vapour diffusion pump, first devised by Gaede in 1915 (Ann. d. Phys. 46, 357). Many varieties of mercury-vapour pump have since been developed—some very simple and inexpensive, others more complicated and costly. Glass (ordinary and pyrex), vitreous silica and steel are employed as materials of construction. All the various types require a preliminary reduction in pressure; some need backing pressures as low as 1/100mm., others will operate at pressures as high as 20 mm. The various varieties all share the advantage of having no mechanically moving parts. The speed of pumping depends on both size and design—some types have a higher speed than any other known pump.

Before taking up the study of the several types of mercury-vapour pump, it will be useful to consider the principles governing the diffusion of mercury vapour and air, so far as they bear on the question of pumping.

In Fig. 8A, molecules of mercury vapour from a boiler are streaming along

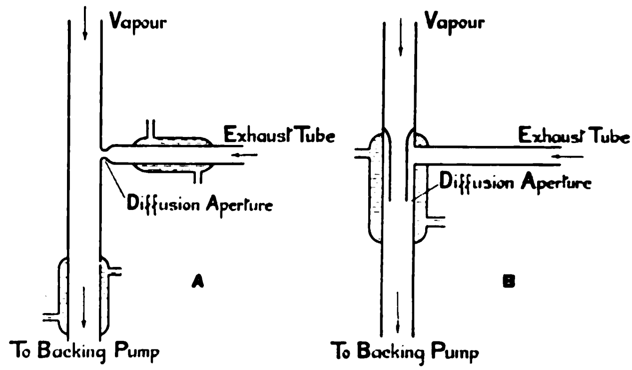

FIG. 8. Diffusion and Condensation Principles.

the main tube towards a condenser and a backing pump. The side tube shown is connected with the vessel containing air which is to be exhausted. The mercury-vapour pressure at the upper end of the main tube is sufficiently large compared with the backing-pump pressure at the lower end to ensure the resulting velocity of the stream being such as to prevent air diffusing backwards against it.

If the size of the aperture connecting the side tube with the main tube is of the right order, the interchange of gases there will be governed by the laws of diffusion. Air from the side tube will diffuse into the main tube, and be carried away by the mercury-vapour stream ; and some mercury vapour will diffuse from the main tube into the side tube, the rates of diffusion depending on the respective partial pressures and the very different molecular weights of air and mercury. The bulk of the mercury vapour passes along the main tube and is arrested by the condenser shown.

There will thus be a steady migration of air molecules from the vessel to be exhausted with a consequent progressive reduction in the air pressure, a reduction which theoretically is without limit. The mercury molecules forming the opposing current through the aperture are removed from the side tube by the condenser there shown.

The crux of the method as a means of pumping lies in the size of the diffusion aperture. Gaede showed theoretically, and afterwards established practically, that the essential condition is that the width of the aperture shall be comparable with the mean free path of the air molecules emerging from the aperture into the mercury molecules. If the aperture

is too wide for the laws of diffusion to operate, a blast of heavy mercury molecules will pass through and overpower the air molecules, which will accordingly be forced back. If the aperture is too narrow the friction will become so great and the diffusion so slow that any pumping action will be stifled.

Given then an aperture of suitable size, it is apparent that, while the speed of pumping will not be affected by the pressure of the air in the side tube, it will depend on the vapour pressure of the mercury and on the backing pressure. If the vapour pressure is too small, air will diffuse back from the lower part of the main tube and so will not be removed by the backing pump. If the vapour pressure is too high, the stream of vapour through the aperture will be so augmented as to hinder the air flow. The conditions for successful pumping are, in fact, very critical.

These difficulties were obviated by Langmuir (Gen. Elect. Rev. 19, 1060, 1916) in whose modification diffusion of the air from the side tube is assisted in two ways :—

(*a*) By so directing the mercury vapour stream as to ensure the more effective entraining of the air molecules.

(*b*) By augmenting the mercury vapour pressure and so the speed of the vapour stream. The objection to this, referred to above, is overcome by mounting a condenser around the diffusion aperture, where, by condensation, mercury vapour is rapidly removed, and the passage of the entrained air thus facilitated in its progress towards the backing pump. The condenser will also serve to retard any back flow of mercury vapour into the side tube.

Langmuir's design may be realised as in Fig. 8B, which illustrates the use of a jet for suitably directing the vapour stream.

We see then that in this " condensation " pump of Langmuir the partial pressure of the mercury vapour trying to pass back through the diffusion aperture is reduced, while the partial pressure of the air diffusing in the other direction is increased. The result is that the speed of pumping, originally low, is greatly augmented. The speed is, however, still controlled by the partial pressure of the air and not by the total pressure. Further, the width of the diffusion aperture round the jet must still conform to the mean free path condition stated by Gaede.

Mercury-Vapour Pump Technique.

Langmuir, in his original paper, stressed the necessity for very effective condensing arrangements, but experience has shown that the pump will work quite well with moderately good cooling devices.

In practice there is, of course, an upper limit to the vapour pressure in a condensation pump, for if the velocity of the mercury stream is pushed up too far, turbulent motion will set in and the pumping will be impaired.

In a glass pump, the boiler of which is being overheated, the critical condition is evidenced by the oscillation of mercury droplets behind the jet.

Clean pure mercury should be used in the boiler, which should be free from dirt, moisture and particularly grease. " Bumping " of the mercury in the boiler is undesirable, and is best avoided by using a wide-bottomed boiler and a shallow pool of mercury. Dunoyer has experimented with arc heating so as to heat from above and obtain high vapour speeds without bumping. Jones and Russell (Phys. Rev. 1917) used the same device in their mercury-arc pump.

If a mercury-vapour pump is required to work at high backing pressures, the velocity of the vapour stream must be increased either by a higher boiler pressure or by a suitably shaped jet. The diffusion aperture must be correspondingly reduced. For low backing pressures a larger jet and a wide diffusion aperuture may be used with advantage. If high vacua are desired from a high backing pressure, it is necessary to run 2 or 3 pumps in series, the several stages having progressively wider diffusion apertures. Each stage acts as a backing pump for the one above it.

Different gases are pumped at different rates. According to the law of diffusion, the speed should vary inversely as the square root of the molecular weight. In actual practice, hydrogen, for example, is evacuated about twice as fast as air.

Gaede Diffusion Pump.

Gaede's original mercury-vapour diffusion pump was constructed of glass, except for the diffusion aperture, which consisted of a narrow horizontal slit in a steel cylinder situated above the boiler. The mercury vapour passes up the inside of the steel cylinder past the slit, down an inner tube and so to a condenser. Vapour diffusing through the slit is arrested by a surrounding condenser. Gas from the vessel to be exhausted diffuses through the slit in the reverse direction, and so joins the main mercury-vapour stream to the rough vacuum. The construction is such that condensed mercury returns to the boiler. A thermometer is present, so that the correct temperature, and so the pressure of the mercury vapour, may be determined. As already mentioned, the adjustment is very critical. The speed is low, about 100 cc./sec. at 1/10mm. backing pressure, which is less than that of the rotary mercury-pump, and much less than that of the molecular pump. Furthermore, the construction is complicated and the pump is now only of historic interest.

Langmuir Glass Condensation Pump.

The action of Langmuir's condensation pump will be evident from what has already been stated. Fig. 9 shows Langmuir's first pump in glass (Gen. Elect. Rev., 1916). The annular diffusion space round the parallel

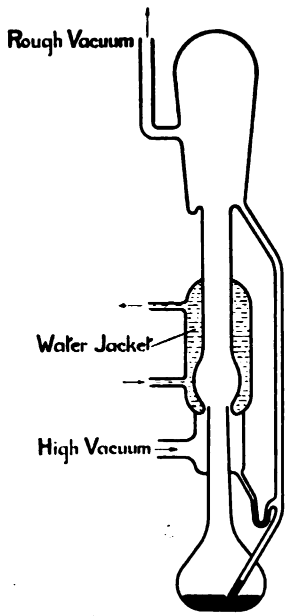

FIG. 9. Langmuir Glass Condensation Pump.

"upward" jet above the boiler and the return tubes for the condensed mercury will be noticed. The end of the condenser is opposite the end of the jet. A liquid-air trap is shown on the high-vacuum side. With air at 1/10mm. backing pressure Langmuir found that the speed varied between 3,000 and 4,000 cc./sec., which marks a great advance.

LATER TYPES OF GLASS PUMPS.

Langmuir's production of the first high-speed mercury-vapour pump has led to further designs by a number of workers, who have chiefly concentrated on the shape of the jet. Parallel, convergent, divergent and annular jets are employed in different types of pumps.

High-speed convergent or divergent jets provided with choke tubes to discharge into are found to be capable of pumping against back pressures as high as 20 mm., though naturally the resulting pressure is not specially low, say 1/1,000mm. or so. An annular jet mounted about the end of the inlet tube is particularly convenient when the latter is of large diameter. In the case of the high vacuum 2 or 3 stage pumps designed for use with high backing pressures, the final stage is a large annular jet, while the first stage is generally a small high-speed jet with a choke tube.

CRAWFORD GLASS PUMP.

The divergent jet was introduced by Crawford (Phys. Rev. 1917) in an attempt to realise a vapour stream in which the molecules move parallel

to one another with equal velocities. When such a stream is directed into a tube of the same diameter as the stream, pumping occurs in the absence of a condenser about the diffusion annulus. The tube can indeed be heated without interfering with the pumping. Normally the tube is air-cooled. In the absence of water cooling it is probable that many mercury molecules are reflected from the walls and are repeatedly re-entrained by the blast.

The maximum speed (about 600 cc./sec. at 0.003mm. pressure) is not high apparently, because, if the pressure is raised by overheating the boiler, mercury vapour accumulates behind the jet. If, however, additional cooling is provided behind the jet, it is found possible to increase the boiler pressure from 12mm. to as much as 108mm., while the maximum speed attained 1,300 cc./sec. at 0.001mm., the backing pressure being 0.05mm.

Volmer Glass Pumps.

Volmer in 1919 designed two jet pumps in glass which may be joined in series, if desired, to form a two-stage pump. The first stage pump, which has an upward parallel jet and choke tube, requires a fore vacuum of a few mms. and pumps down to about 10^{-3}mm. The second-stage pump is of the downward annular-jet type with internal water cooling. According to Ebert at the Reichsanstalt (Zeit. f. Phys., 1923), if the backing pressure is 1mm., such a combination may have a speed of about 1,700 cc./sec. at 7×10^{-3}mm. pressure, and about 500 cc./sec. at 2×10^{-6}mm. pressure.

Vitreosil Pump.

The high temperature gradients which of necessity occur in water-cooled glass pumps are apt to lead to fractures. These are avoided by the use of vitreous silica, an example of which is the single-stage "Vitreosil" pump made by the Thermal Syndicate. Clear silica is used in the construction of the pump, which is small and compact in design. About 5 ccs. of mercury are required in the boiler, so that the pump will soon start up from cold. The speed is given as 200 cc./sec. and the attainable vacuum as 2×10^{-6}mm. with a backing pressure of 0.2mm. Either gas or electric heating may be used.

Stimson (Journ. Wash. Acad. Sci., 1917) has described a two-stage pump, the two stages, which are connected in series, being fed from a common boiler. The first stage, which can be backed with a filter pump, has a convergent jet and choke tube, the second a long divergent jet of the de Laval type.

G.E.C. 3-STAGE PUMP.

Where it is desired to produce high vacua from considerable backing pressures, a third stage may be added. Fig. 10 shows a glass pump

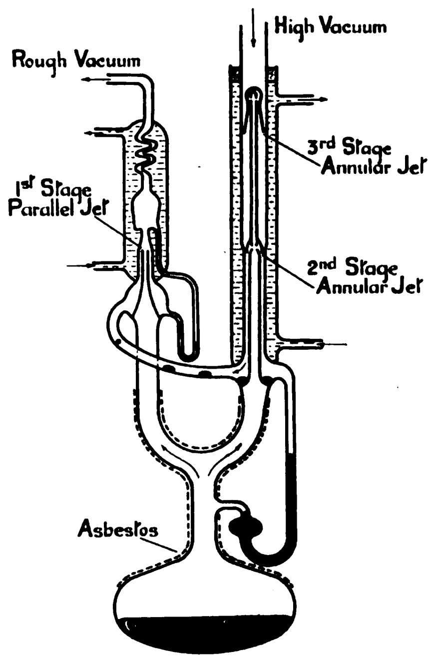

FIG. 10. G.E.C. 3-stage Glass Pump.

developed by the Research Laboratories of the British General Electric Company. All three stages are fed by the one boiler. The first stage, with its convergent jet, resembles that of Volmer, but the second and third stages, which form the other limb of the pump, are quite different, each consisting of a downward annular jet, formed by a glass umbrella mounted immediately over holes in the central vapour tube, which is common to both stages. In the third stage the deflector is so shaped as to form a large expanding annular jet. It may be noted that the connecting tube between the first and second stages serves a double purpose, mercury returning down it in one direction while gas passes from the second to the first stage in the opposite direction. The pump will operate with backing pressures as high as 20 mm., and is fast enough for the work of exhausting the largest valves.

LANGMUIR STEEL CONDENSATION PUMP.

Langmuir originated in 1916 (Gen. Elect. Rev. 19, 1060) the first single-stage steel condensation pump (Fig. 11). The pump is of the downward

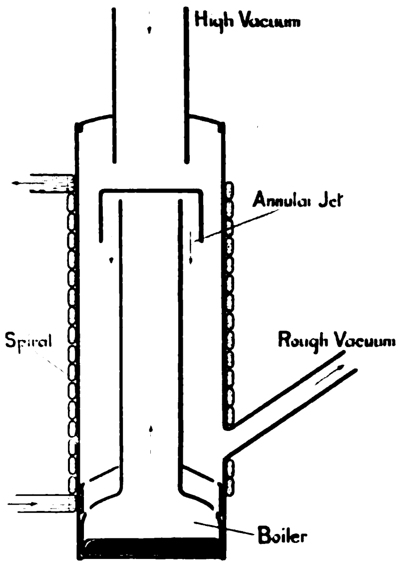

FIG. 11. Langmuir Steel Condensation Pump.

annular jet type, a deflector turning the mercury vapour stream downwards against the cooled walls, so that the entrained gas passes from the upper inlet pipe shown to the outlet pipe in the side of the pump. Condensed mercury returns to the boiler by the small holes provided. Either gas or electric heating is employed, about 300 watts being required to keep the boiler at about 100°C. which is a suitable working temperature. The jet and diffusion annulus are each about 1 cm. in width. The pump requires a backing pressure of about 1/100mm. Pressures down to about 10^{-6}mm. are obtainable with a fore vacuum of 1/100mm., when the speed is from 3,000 to 4,000 cc./sec. As all joints are welded, access to the interior of the pump is not readily possible.

STEEL "BOTTLE" PUMP.

An extremely simple design of mercury-vapour pump in steel, which, by reason of its shape, is often called a "bottle" pump, has found extensive industrial use. On the assumption that mercury molecules from the boiler do not rebound on striking the cooling walls, the molecules reaching the level of the aperture into a side tube will all be moving parallel to the walls, provided the distance from the boiling mercury is sufficiently great. Thus, little mercury vapour will enter the side tube and the "jet" of Langmuir's metal pump may be dispensed with. The pump, which is made of sheet metal, and, incidentally, is not very easy to clean out, requires a fore vacuum of about 1/100mm. The speed in the case of air is about

1,500 cc./sec. and is set by the dimensions of the inlet tube rather than by the pump itself.

STEEL ANNULAR JET PUMP.

A number of designs of mercury-vapour pumps constructed of steel have been developed at the National Physical Laboratory (Backhurst & Kaye, Phil. Mag. 1924; Kaye, Phil. Mag. 1926). The most recent design is a single-stage pump of the downward annular-jet type, designed to work at back pressures up to 5mm. The construction is simple and the pump is one which can be made in any good workshop. Most of the details of the pump are given in Fig. 12.

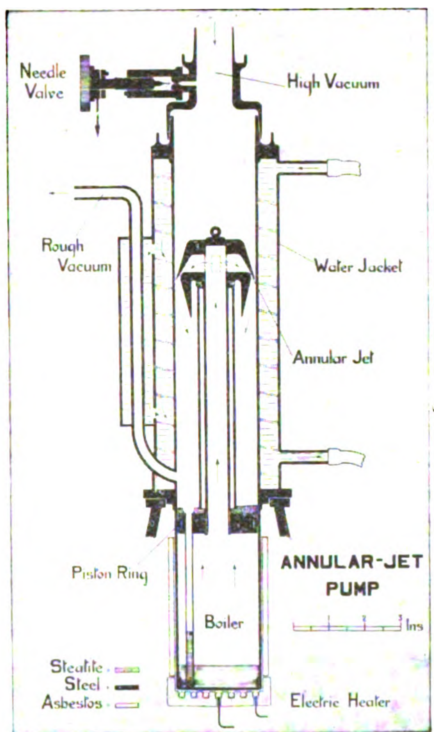

FIG. 12. Steel Annular-jet Pump.

The action of the pump is as follows:—Mercury-vapour from the boiler passes up the centre tube and through holes at the top to the annular space between the two deflectors, whence it issues as a jet and entrains gas diffusing from the annular space between the upper deflector and the outer casing. Below this, in the region between the outer casing and the

inner tube, condensation of the vapour takes place, the condensed mercury returning to the boiler and the entrained gas passing on to the backing pump.

The body of the pump is of solid drawn steel tubing of 1/16th inch wall-thickness. The bottom of the boiler, which is of the same thickness, is welded to the walls. The top of the boiler is purposely designed to be withdrawable, and the effective sealing of the boundary is effected either by a mercury seal or by constructing the boiler top like a piston and using a "Clupet" piston ring. The ring is "lapped in" much as is a piston ring in the cylinder of an engine, any scale being first removed.

It is desirable that the top of the boiler shall be kept relatively cool to prevent re-evaporation of condensed mercury. This is achieved by thermally insulating the top by a disc of baked steatite, the upper surface of which is inclined so as to assist the condensed mercury to find its way back to the boiler by the return tube. Baked steatite is also used to insulate and support the tube which thermally "jackets" the central vapour tube.

The two deflectors enclosing the annular jet are shaped to secure favourable expansion conditions for the jet. The widths of the jet and of the adjacent diffusion annulus are each 1/32 inch. A uniform diffusion clearance is secured by leaving three small outward projections equally spaced on the lip of the upper deflector. The boiler-top, the central vapour tube and the jet system form a unit which can be readily withdrawn from the pump for examination or cleaning purposes.

The pump is cooled by a closed water jacket, the flanges of which are welded on. A helix of copper tape inserted in the jacket causes a swirling action of the water, the cooling being very efficacious. The water jacket is extended some distance above the jet so that, although the design utilises a greater boiler pressure and a higher jet velocity than are customary in a single stage pump, but little stray mercury vapour finds its way to the high-vacuum side of the pump.

The upper end of the pump is closed with a steel cap fitted with a ground-joint. A second ground-joint of standard taper forms the connection between the steel cap and the glass connecting tube of the apparatus to be exhausted. Suitable troughs allow mercury seals to be used if desired. Either electric or gas heating may be employed. Five hundred watts or six litres of coal gas per minute are suitable for normal heating, but these figures may be doubled at the higher backing pressures. A backing pressure of 4 to 5 mm. is sufficient for most purposes, and the highest vacua may be attained with a backing pressure of 1½mm. The speed reaches a maximum of about 7,000 cc./sec. The amount of mercury in the boiler is 50 cc.; and, as a result of the low thermal capacity, the pump, using gas heating, will operate within three minutes from cold.

GAEDE 3-STAGE STEEL PUMP.

Gaede has designed a large 3-stage steel pump for use against back pressures up to 20mm. All three stages are contained in a single vertical steel tube, the lower end of which forms the boiler, while the remainder, which is water jacketed, is divided into three separate compartments by discs which are made gas tight by the use of mercury-sealed leather cups. A central vapour tube feeds all three stages. Each of the first two stages has a plain jet of slightly expanding form, which is directed downwards into a choke tube forming part of the disc which separates the stages.

Special trapping devices are employed in each stage to permit the return of condensed mercury without loss of vacuum. In the first stage provision is made in the form of a solid rod attached to the cooled disc above, for assisting in preventing re-evaporation of the condensed mercury in the return tube to the boiler.

Leakage through the top cap is minimized by an internal mercury seal exposed to the rough vacuum of the backing pump. Either gas or electric heating may be employed. The power required is 1 k.w.

The pump has the great speed at 10^{-3}mms. of about 15,000 cc./sec. in the case of air. This speed is really conditioned by the diameter of the high-vacuum inlet tube, as the speed is 40,000 cc./sec. at the top jet. A backing pump of high capacity is essential.

INDUSTRIAL APPLICATIONS OF THE STEEL PUMP.

The development of the robust high-vacuum pump has been followed by large-scale industrial applications. For example, in order to exhaust a vacuum furnace of about 74 litres capacity, Sir Chas. Parsons in 1919 (Journ. Sci. Inst., 1925) constructed a single-stage mercury-vapour pump of steel, with a divergent annular jet expanding to nearly 5 inches in diameter. The backing pressure required was ½mm. and the boiler pressure was 380mm. The boiler held 1 cwt. of mercury and was structurally separated from the rest of the pump.

From the figures published by Parsons it is possible to make an approximate estimate of the speed of the pump. At a mean pressure of 0.25mm. the 'overall' speed was about 7,500 cc./sec., the vacuum furnace being exhausted to beyond an X-ray vacuum in 1½ minutes.

An even more impressive application of the steel mercury-vapour pump is to be found in the Brown Boveri vacuum system for maintaining high-power mercury-arc rectifiers at about 1/100mm. pressure. Such rectifiers range up to 2,000 k.w. at 1,800 volts and over 1,000 amperes. The pump is a modification of the 'bottle' type and is backed by a large rotary oil pump. The whole pumping system has to be insulated for high voltages, and is automatically controlled by a hot-wire manometer and relay, which starts or stops the electric heating, the water cooling and the backing pump. See Fleming's "Mercury-Arc Rectifiers," (Pitman).

OBITUARY.

Sir Charles Tamlin Ruthen, F.R.I.B.A., O.B.E.—Sir Charles Ruthen, who died at his Swansea home on September 19th at the age of 54, possessed a profound knowledge of all matters connected with the building industry allied to exceptional organising powers. Born at South Shields on October 22nd, 1871, the son of Mr. John Ruthen, he entered at the age of fifteen the office of Mr. Matthew Hall of that town. After remaining there for four years, he became, in 1890, Assistant Surveyor to the Swansea County Council. In 1896 he began practice in Swansea on his own account, and designed many public and private buildings in that city. The shortage of Government office accommodation during the war and the housing shortage after the war provided an opportunity for the exercise of Ruthen's gifts for organisation and for his great technical knowledge. In 1917 he was deputed by the War Cabinet Committee on Accommodation to examine and report on the use made of their available accommodation by Government departments, and this led to his appointment in 1918 as Chief Inspector of Accommodation in the London area, and in 1920 as Consulting Chief Inspector of Government Accommodation. He was a member of the Grants Committee of the Ministry of Labour and of the General Advisory Committee of the Empire Timber Exhibition of 1920.

It was as Director of Housing at the Ministry of Health—an office to which he was appointed in 1921 and only resigned last July—that Ruthen's great services to the cause of national housing were rendered. In September, 1921, he presided as Chairman over a Government Commission which visited Belgium to investigate housing and labour conditions there; in 1923 he was appointed a member of the Interdepartmental Committee to inquire into the effect of trade combinations upon prices in the building industry; in 1924 he became a member of the Government Committee to inquire into new methods of house building, and in 1925 of the Board of Education Committee to consider methods of school building. It is a significant commentary upon his ability to handle the housing problem that, as a result of his strict rationing of local housing programmes and firm attitude towards contractors, the price of working-class houses fell several hundred pounds within a few months of his arrival at the Ministry of Health.

Sir Charles Ruthen, who always refused to accept any remuneration for his services to the Government, was knighted in 1919. He was President of the Institute of Contractors, the Institution of Structural Engineers and the Institute of Arbitrators, a member of the Council of The London Society, and also from 1920 to 1922 President of the Society of Architects He had been a Fellow of the Royal Society of Arts since 1917.

NOTES ON BOOKS.

Tadhkirah. By Muhammad Inayatullah Khan

The monumental *Tadhkirah* " Memoir " by Mr. Muhammad Inayatullah Khan, of which the first volume has been presented to the Society, describes itself as a final message to the Moslems of the world, bearing on their social life and death, and a scientific interpretation of the true objects of the Koran and proof that that work comes from God. It is to occupy ten folios; the first is in three parts; an Arabic Homily occupying 144 pages; an Urdu Introduction, occupying 132;

and the commencement of the actual work, also in Urdu, filling 272 pages. The author has provided elaborate tables of contents, and lists of Koranic texts quoted. Urdu is little known outside India; Arabic a somewhat rare accomplishment among Indian Moslems; however, the Prophet Daniel set the example of writing different portions of the same book in different languages, and, since the Arabic portion of the work before us is quite in the style of an Israelitish prophet, the Indian writer has good authority for his procedure. The Moslems are told in fairly emphatic language that they have been neglecting the true import of their sacred book, and that the European savants have been following its precepts more faithfully than they. The Egyptian Sheikh Tantawi Jauhari told his countrymen much the same in a series of volumes on a very much smaller scale. The Urdu Introduction finds fault with European savants for neglecting the revelations of the Prophets. The main work is occupied with demonstrating that the Koranic texts contain implicitly all that European science has by its laborious methods ascertained. So far as a foreigner can judge, Mr. Inayatullah Khan seems to write both Arabic and Urdu with ease and considerable charm of style. Neither his religious opinions nor his scientific theories are quite suitable for discussion in this Journal; but his assertion that the Moslems of the last three centuries have been decadent is only true if we confine our attention to military power. It is not true if we extend it to military capacity, for Muhammad Ali Pasha and Ibrahim Pasha were probably as capable as any earlier Moslem generals. The dividing line between progress and stagnation would seem to be geographical and climatic rather than religious.

CONFERENCE ON BITUMINOUS COAL.

The Conference on Bituminous Coal to be held at the Carnegie Institute of Technology, in Pittsburgh, Pennsylvania, U.S.A., has been definitely scheduled for November 15 to November 19, 1926, according to an announcement from the institution.

As a result of a visit to Europe this summer by Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, several distinguished scientists and fuel technologists in Europe have accepted his invitation to attend the congress. German representatives will include privy councillor Professor Franz Fischer, Director of the Institute for Coal Research at Mulheim, Ruhr, and Dr. Friedrich Bergius, of Heidelberg. England will be represented by Dr. C. H. Lander, Director of Fuel Research of the Department of Scientific and Industrial Research, Dr. R. Lessing, the well-known fuel technologist, and Mr. Geoffrey Gill, engineer and specialist in the manufacture of gas. From France will be General Georges Patart, who was in charge of the manufacture of explosives during the war and who is the inventor of a process for making methyl alcohol from coal. In addition, there will be a representative from the Office National des Combustibles Liquides. Besides these there will be a number of European specialists who have done work in the development of certain processes.

American scientists, chemists, and fuel technologists who have been doing important research work in the chemistry of coal and other problems will have a large share in the program.

The purpose of the meeting is to bring together the men of all countries who have done notable work in the study of more scientific and rational utilization of soft coal. Among the subjects set down for discussion are such questions as the manufacture of substitutes for gasoline from coal; the complete gasification of

coal; high temperature and low temperature carbonization; by-products; smokeless fuel; pulverized coal; hydro-electric power versus steam power, etc.

The members of the Advisory Board assisting in the development of the conference plans include the following American men of affairs: Messrs Andrew W. Mellon, Secretary of the United States Treasury; John Hays Hammond, engineer and inventor; Otto H. Kahn, banker; Charles M. Schwab, steel manufacturer; Samuel Insull, public utility expert; E. M. Herr, president of the Westinghouse Electric and Manufacturing Company; and Dr. Frank B. Jewett, vice-president of the American Telephone and Telegraph Company, and director of research of the Bell Telephone Research Laboratories.

GENERAL NOTE.

THE CONDITIONING OF AIR.—The question of air conditioning as an aid to industry was dealt with by Mr. J. W. Cooling, M.Sc., at the recent Summer Meeting, at Scarborough, of the Institution of Heating and Ventilating Engineers. This subject, he stated, had not been given the attention it deserved. In America, where weather conditions were more severe, it was almost imperative in certain industries. Apart from industrial uses, air conditioning had become necessary in connection with mechanical ventilation. Incidentally, in factories for the manufacture of certain kinds of products, apart from its beneficial effects on the operatives, clean air was necessary. In some cases it was essential to have almost sterile air, and this could readily be obtained by means of modern air conditioning. By similar means there was no reason why factories manufacturing cheap cabinet work under mass production should not turn out work with parts which fit as well as hand made work. Its necessity was to be met with in nearly all industries employing hygroscopic materials, such as cabinet making, textiles, printing and paper making. Particulars of a modern air conditioning plant and of the application to it of automatic control were given, as well as a concrete example of the calculations involved in the design of the apparatus for a factory where it was proposed to maintain a certain specified temperature and humidity for either summer or winter.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, OCTOBER 4..Chemical Industry, Society of, at Burlington House, Piccadilly, W. 8 p.m. Dr. E. K. Rideal, "Recent Advances in Catalysis."

Engineers, Society of, at Burlington House, Piccadilly W. 5.30 p.m. Captain W. J. Liberty, "The History of Artificial Lighting."

Transport, Institute of, at the Institution of Electrical Engineers, Victoria Embankment, W.C. 5.30 p.m. Mr. R. H. Selbie, Presidential Address.

TUESDAY, OCTOBER 5..Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Professor Arthur Thomson, D.C.L., F.R.C.S., "Anatomy. Lecture I.—Introductory—Man's Erect Posture, and the Characteristic Features dependent thereon."

Automobile Engineers, Institution of, at the Royal Automobile Club, Pall Mall, S.W. 8 p.m. Mr. H. Kerr Thomas, Presidential Address, "The Debt of the Country to the Automobile."

WEDNESDAY, OCTOBER 6..Analysts, Society of Public, at Burlington House, W. 8 p.m. The following Papers will be read:—(1) Mr. A. Chaston Chapman, F.R.S., "On the Presence of Compounds of Arsenic in Marine Crustaceans and Shell Fish." (2) Messrs. Arnold R. Tankard and D. G. T. Bagnall, "The Examination of Fish for Formaldehyde" (3) Mr. Karl Sandved, "Potentiometric Titration of Tin with Potassium Bromate." (4) Mr. R. R. T. Young, "The Determination of Nicotine in Tobacco."

THURSDAY, OCTOBER 7..Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.30 p.m. Colonel the Master of Sempill, "Aero Engine Fuels of To-day and To-morrow."

FRIDAY OCTOBER 8..Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Professor Arthur Thomson, D.C.L., F.R.S., "Anatomy.—Lecture II.—The Bones and Muscles of the Trunk and the Surface Forms dependent thereon, in Action and Repose."

SATURDAY, OCTOBER 9..L.C.C., The Horniman Museum Forest Hill S.E. 3.30 p.m. Mrs. Robert Aitken, "Life in a Red Indian Family."

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All communications for the Society should be addressed to the Secretary, John Street Adelphi, W.C. (2.)

NOTICES.

TRUEMAN WOOD LECTURE.

The Trueman Wood Lecture will be delivered this year on October 27th, at 8 p.m., before the formal opening meeting of the Session on November 10th, owing to the fact that the lecturer has to return to New Zealand before the latter date. The lecture will be given by DR. ROBIN JOHN TILLYARD, M.A., Sc.D., D.Sc., F.R.S., F.L.S., Chief of the Biological Department of the Cawthron Institute of Scientific Research, Nelson, New Zealand, on "The Progress of Economic Entomology." SIR THOMAS HENRY HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, will preside.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE PRODUCTION AND MEASUREMENT OF HIGH VACUA.

By G. W. C. KAYE, O.B.E., M.A., D.Sc,

Superintendent of the Physics Department, The National Physical Laboratory.

LECTURE III.—*Delivered March 1st*, 1926.

ABSORPTION METHODS OF EXHAUSTION.

VARIOUS ABSORBENTS.

Almost all solid materials in a suitable physical state are capable of absorbing gases, in some cases in large quantities. For example, calcium (heated to 700°C.) and the alkali metals will combine with gases other than

the inert group and form solid compounds with negligible vapour pressures. Among other materials which have found application are charcoal, palladium black, platinum black, finely divided copper, phosphorus, sulphur, iodine, arsenic, silica, magnesium, thorium, tungsten, tantalum, zirconium, some of which show marked absorptive effects in suitable circumstances.

The absorption method is of particular value in the case of vacuum apparatus which is sealed off from the pump, as a suitable absorbing medium is capable of "cleaning up" gases liberated from the sealing-off process, or from the normal operation of the apparatus during its life.

The commercial use of heated metallic thorium powder as a means of freeing argon from other gases may be referred to. If thorium is heated in air, the nitrogen, oxygen, CO_2, etc., are rapidly absorbed with the production of a surface glow. Activated palladium black, which operates in the cold, also finds a limited commercial application.

CHARCOAL AND LIQUID AIR.

The most outstanding, however, of all gas absorbents is charcoal. The ability of charcoal to absorb gases at ordinary temperatures has been known for many generations. Its use in gas masks during the war will be recalled. As we have already remarked, Dewar's discovery in 1904 that the absorptive effect is enormously enhanced by cooling to liquid-air temperatures, opened up a new era in the rapid production of vacua of a degree hitherto unattainable.

The charcoal is conveniently placed in a glass tube which forms a side limb to the apparatus to be exhausted. The charcoal is heated while the backing pump is in operation until the evolution of gas moderates. At this stage the apparatus is cut off from the pump and the charcoal allowed to cool, when a substantial pressure reduction will occur. The containing tube is then immersed in liquid air when a vacuum will normally result, which in suitable circumstances may be so high as to be unmeasurable. Several charcoal tubes may be provided if needs be. These should be used in 'series' each tube taking up its work at the pressure where the previous tube has left off. The particles of charcoal should be about $\frac{1}{8}$ inch in diameter. A loose plug of glass wool will prevent charcoal dust passing into the rest of the apparatus.

The denser yet more porous charcoals have been found to be the most effective for the purpose of absorbing gases. The degree of porosity depends upon the source of the charcoal and its treatment. The shell of the cocoanut and a number of fruit kernels are among the best sources. They are first carbonised to charcoal at moderate temperatures (400°-500°C.) and then "activated" by heating for some hours in retorts at 800° to 900°C. or by the action of superheated steam, either of which processes remove hydro-carbons.

A good charcoal will absorb as much as 1,000 times its own volume of gas, but the actual amount depends on the gas and on the conditions. The literature is extensive and the published results are not always easy to reconcile, but it appears to be true that, apart from vapours and inert gases, the absorbability increases with the boiling point. It should be noted, however, that in a mixture of gases the several gases do not act independently. The differential absorbability of different gases is of a commercial importance in the purification of helium. As will be seen from the results of Dewar given in the Table, the absorbability increases as the temperature is lowered. The absorption of oxygen is apt to be anomalous owing to chemical combination with the charcoal. The low absorption figure for helium is much increased at the temperature of liquid hydrogen.

Gas.	Boiling Point.	Vol. in c.c. at N.T.P. of absorbed gas per c.c. of charcoal at	
		0°C.	—185°C.
Oxygen	—183°C.	18	230
Argon	—186.2	21	190
Nitrogen	—195.8	15	155
Hydrogen	—252.9	4	135
Helium	—268.6	2	15

As regards the "pumping" speed of liquid air and charcoal, the rate falls off rapidly as the equilibrium pressure is approached. Down to, say, 0.0001mm. the method would be accounted rapid, but below that pressure the speed is probably inferior to that of a good mercury-vapour pump.

With reference to the mechanism of absorption, charcoal is known to be full of countless numbers of fine capillaries of diameters averaging between 10^{-5} and 10^{-6} cm., or possibly even of molecular sizes. The combined volume of these tiny capillaries may amount to half the volume of the charcoal. It is estimated that, through the medium of these capillaries, 1 gramme of charcoal may have a surface up to 2,500 sq. metres or half an acre. It is assumed that the gas rapidly enters these capillaries, where it is absorbed with the evolution of heat within a few minutes, this being followed by the slower diffusion into the material of the charcoal, which may take hours. There are also present in charcoal much larger pores which are relatively inactive. In the case of water vapour the tiny capillaries may also provide an opportunity for capillary action.

The use of charcoal as an absorbent has commercial importance in the manufacture of metal liquid-air containers. Such containers include among their uses that of supplying oxygen for pilots of aircraft flying at

high altitudes. The design is such that a re-entrant pocket of charcoal at the botton of the container is cooled when liquid air is present, so that from an initial rough vacuum a suitably high vacuum is produced and maintained in the jacket. Activated colloidal silica is also used, but is in general inferior to charcoal at high vacua, although superior for certain gases at atmospheric pressure. Silica possesses, however, a real advantage when the flask is exposed to the risk of accident, e.g., perforation by a bullet, which would flood the charcoal with liquid air with the possibility of explosive consequences. (See Report of the Oxygen Research Committee, H.M. Stationery Office, 1923).

The Progressive Hardening of Discharge Tubes.

The progressive lowering of the gas pressure in a discharge tube was noticed as long ago as 1858 by Plücker. The cause of this has been the subject of a good deal of enquiry. The effect is undoubtedly not a simple one, and there appear to be several contributory causes. X-ray workers with the gas type of tube are very familiar with the phenomenon, which is probably due in great part to the presence of positive ions which bombard the glass walls and are mechanically held there. It is well known that the greater part of the walls are positively charged while the discharge is passing.

The production of positive ions is stimulated by the generation of metallic vapours, such as would result from the bombardment of the metal electrodes. These vapours condense on the glass walls, and either absorb or mechanically trap the gas. The absorbed gas can be driven off by heating the walls, but the cure is only a temporary one.

The "Clean up" of Gases in a Vacuum.

The above hardening phenomena can be turned practically to account by producing positive ray bombardment through the medium of a suitable applied voltage. In this way a 'clean up' can be effected in the case of a vacuum vessel sealed-off from the pump. But a method of greater practical value, to which reference has already been made, is to use 'getters' for cleaning up residual gases in a moderate vacuum.

The literature of the 'clean-up' of gases is extensive and the results are not always easy to reconcile, but from the multiplicity of experimental data it would appear that :—

(1) The clean up is greatly enhanced by the process of vaporisation of the getter in situ—a process which probably results in disruptive ionisation and the possible temporary formation of atomic modifications of either getter or gas or both, which are extremely active chemically, and so combine to form solid compounds with negligible vapour pressures. Such ionisation would account for the 'blue glow' well known to lamp and valve makers—

an effect which does not occur if the preliminary exhaustion has been specially effective. As already remarked, the blue glow is accompanied by positive ion bombardment and disintegration of the filament, so that the manufacturer now tries to avoid the production of the glow, at any rate in the case of large valves.

(2) The removal of the gas is completed by a film of the getter which is deposited over the surface of the glass walls, and holds the gas either by absorption or trapping. This forms a steady ' corrective' on gas emission throughout the life of the apparatus.

The above seem to be the salient facts in the clean-up of gases by heated tungsten, phosphorus, magnesium, etc. A similar gas absorption is produced by the vaporisation of alkaline fluorides and chlorides, sodium silicate, silica or powdered glass when heated on a filament. Presumably any substance that can be sublimed acts in the same manner.

In the case of electric lamps the getter is an alcoholic solution of red phosphorus and a salt such as sodium silicate. One end of the filament system is dipped into the getter, and when the lamp is subsequently flashed the phosphorus is volatilised from the heated filament.

As regards receiving valves, the getter is usually a tiny strip of magnesium which is flashed by a high-frequency induction device and so volatilised on the walls. Barium nitride is added in the case of dull-emitter valves, the vapourised barium being deposited on the filament and on the walls.

Lilienfeld describes an interesting method of hardening a high-vacuum X-ray tube by the use of an annexe containing a pointed cathode, directed towards a volatilisable anode which acts as a getter.

Mention should also be made of the Lodge X-ray valve, an early example of the use of phosphorus in vacuum work.

HIGH VACUUM GAUGES.

The ordinary barometric gauge is of little service for pressures less than a few millimetres. The same remark applies to the familiar U-shaped mercury gauge, the open end of which communicates with the apparatus and the closed end is filled completely with mercury, so that the gauge measures the degree of departure from a Torricellian vacuum.*

TILTING GAUGES.

Rayleigh's mercury tilting gauge (Phil. Trans. 1901) can be used to measure steady pressure-differences ranging between 1.5mm. and 10^{-3}mm. The tilting gauge has been elaborated by Chattock (Phil. Mag., 1901) in his tilting water manometer. The Chattock gauge has been further

* For other types of differential gauges using oil or water, see Pannell's Measurement of Fluid Pressure and Velocity." (Arnold).

developed in the Aerodynamics Department of the National Physical Laboratory.

If necessary, the water vapour from the gauge may be prevented from passing into the apparatus by means of a trap, a precaution which applies also to oil gauges.

HIGH VACUUM GAUGES.

To come now to what may perhaps be termed true high-vacuum gauges. These may be conveniently considered under five groups :—

(1) Those which depend on Boyle's law, such as the McLeod gauge.

(2) Those which measure molecular bombardment due to temperature difference, such as the radiometer gauge of Knudsen.

(3) Those which utilise the frictional drag of molecules on a moving surface, such as the decrement gauges and the " molecular " gauge of Langmuir and Dushman.

(4) Those which turn to account the thermal conductivity of a gas, such as the hot-wire gauge of Pirani.

(5) Those which make use of the electrical conductivity in a gas, such as the ionisation gauge of Buckley.

Of these the first two—the McLeod and Knudsen gauges—are the only ones which give absolute readings. The rest all require calibration.

It is unfortunate that, just as the most useful of high-vacuum pumps—the mercury-vapour pump—introduces mercury vapour into an apparatus, so does the most convenient absolute gauge—the McLeod gauge—introduce mercury vapour also. In either case, of course, a liquid air trap will remedy matters.

The choice of gauge may be dictated by the experimental conditions or requirements, e.g. whether the pressure variations are slow or rapid, or whether recording or automatic control devices are required.

(1) GAUGES DEPENDING ON BOYLE'S LAW.

THE MCLEOD GAUGE.

The well-known McLeod gauge was designed by Prof. McLeod of Coopers Hill College in 1874 (Proc. Phys. Soc.). It still finds extensive use in high vacuum work, and forms a very convenient means of calibrating most other pressure-measuring devices.

The McLeod gauge is essentially a device by which a sample of the gas the pressure of which is desired is compressed from a large bulb of known volume into a capillary tube of known volume, the pressure required to do this being measured.

This is achieved in the simple design shown in Fig. 13 by lifting the mercury reservoir connected to the rubber tube. The rising mercury first

cuts off access to the side tube leading to the apparatus, and the whole of the entrapped air in the upper bulb and capillary is gradually compressed into the closed capillary. The excess pressure required to do this is shown on the adjacent open capillary tube which is of like diameter to avoid unequal capillary depression.

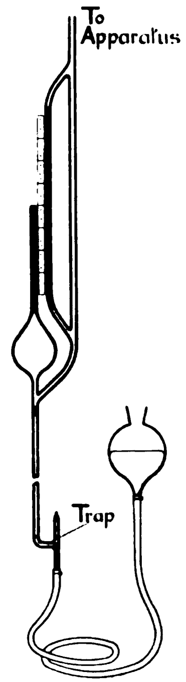

FIG. 13. McLeod Gauge.

If V is the volume of the bulb and capillary, v is the volume of the capillary, and h is the difference in height in millimetres of the mercury in the two capillaries, then, provided the gas obeys Boyle's law and the temperature has kept constant, the pressure in millimetres which it is desired to measure is

$$p = \frac{vh}{V}$$

This is the orthodox method of using the gauge and one which leads to a uniform scale of pressures on the open capillary.

A second method of using the gauge which is convenient for some purposes is to bring the mercury in the open capillary always to some selected zero, and to read off the position in the closed capillary which must have been previously calibrated. Then, if v_0 is the volume of 1mm. length of the

closed capillary, h_1 is the difference of heights in millimetres, and a, is the distance in millimetres of the selected zero above the end of the closed capillary,

$$p = \frac{v_0(h_1 - a)}{V} . h_1$$

If the selected zero is opposite the end of the closed capillary, then

$$p = \frac{v_0 h_1^2}{V}$$

This method, which leads to a non-uniform scale of pressures on the closed capillary, is more sensitive for low than for high pressures.

With either method the dimensions of the bulb and closed capillary must have been selected to suit the range of pressures required. The volumes of the bulb and capillary are previously determined by filling with mercury and weighing. A correction for meniscus curvature may be necessary in view of the fact that the bulb and capillary are calibrated when upside down. It is not practicable to diminish the bore of the capillary beyond ½mm. The end of the closed capillary should be sealed off as squarely and abruptly as possible. Care should be taken that the length of the open capillary is adequate for the higher pressures—500c.c. may be taken as a convenient maximum volume for the bulb. The fall-tube must be of full barometric height. Clean distilled dry mercury should be used. If the gauge has been standing unused for some little time a preliminary sweep through of the mercury by raising the reservoir may advantageously be carried out before beginning to take readings.

The McLeod gauge is slow in action and so is unsuitable for the measurement of rapid variations of pressure. It will not correctly record the pressure of any vapours present. The various types usually made cover a working range from a few mms. to 10^4 or even to 10^5mm. in favourable circumstances, the accuracy being about 1% at the higher pressures. The increase of pressure in the capillary during an observation may amount to as much as 10,000 or 100,000 fold. The original McLeod gauge has been improved and elaborated by a number of workers. The addition of a wide by-pass (shown on the right in Fig. 13) to establish freer communication between the apparatus and the gauge appears to be due to Gaede. The trap at the bottom of the fall tube is to catch air arising from the presence of the rubber tubing.

(2) Gauges depending on Molecular Bombardment due to Temperature Difference.

We come now to the second group of gauges which have been developed from the radiometer invented by Crookes some fifty years ago, in an attempt

to devise an instrument to measure the pressure of light. The motion of the radiometer vanes was studied by Maxwell, Osborne Reynolds and Schuster, who were able to account for the facts on a theory of molecular bombardment of the vanes, the degree of recoil depending on the temperature of the surface.

In 1910 the theory was elaborated quantitively by Prof. Knudsen, of Copenhagen (Ann. d. Phys., 1910). His calculated results deal with the repulsion between a hot and a cold plate in an enclosure, and constitute the basis of a number of types of high-vacuum gauges. There are two main classes—in one the repulsion is measured as a torque, in the other as a direct deflection.

Knudsen's Radiometer Gauge.

Knudsen's radiometer gauge is noteworthy in being the only high-vacuum gauge, one form of which is capable of giving absolute readings and is also independent of the nature of the gas or vapour. Unfortunately, the gauge is not particularly easy either to make or to use.

The gauge in its usual form consists essentially of two stationary and two moveable plates, the latter being suspended from a quartz fibre carrying a mirror and capable of rotation. The relative disposition of the fixed and moveable plates is shown in Fig. 14. The fixed plates are of platinum and

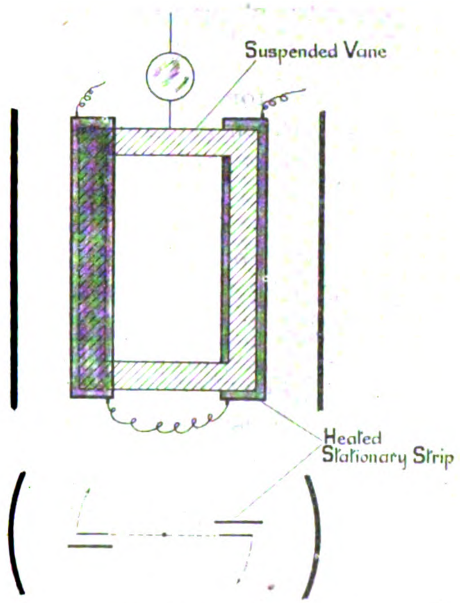

Fig. 14. Knudsen Radiometer Gauge.

are electrically heated. If the pressure is such that the mean free path is much longer than the distance between the fixed and moveable plates, there will be a repulsion of the cold plates to an extent which is directly proportional to the pressure. While both sides of each cold plate are bombarded by molecules, those coming from the hot plate will have the higher velocity. The degree of repulsion of the cold-plate system is measured by the deflection of the mirror as indicated by a beam of light. The relative dimensions of the hot and cold plates should be such that edge effects can be neglected, and the temperature difference between the plates should not be too great.

Knudsen's calculations led to the following formula for the gas pressure:—

$$p = \frac{2R}{\sqrt{\frac{T_1}{T_2}} - 1}$$

where R is the repulsion per sq. cm. of one plate, T_1 is the absolute temperature of the hot plate and T_2 is the absolute temperature of the cold plate. Now R is completely calculable in terms of the dimensions of the cold plate, and the moment of inertia, the period of oscillation, and angle of deflection of the cold-plate system. Thus, if T_1 and T_2 can be measured, the absolute value of p can be calculated. The range of the instrument is from about 10^{-3}mm. down to the highest attainable vacua. It is possible to use the gauge at somewhat higher pressures, but only by calibration.

The instrument is very sensitive to tremor. Further, the torsion control of the repulsion is apt to be troublesome at low pressures, owing to the virtual absence of damping and the relatively large moment of inertia of the suspended system. If an external means of damping is utilised, it is apt to result in a drifting zero.

(3) Gauges Depending on the Frictional Drag of Molecules.

The next group of instruments depend for their action on the frictional drag of gas molecules slipping past a solid surface. As Maxwell showed long ago, the viscosity is independent of the pressure for exhaustions down to about 1mm. But at lower pressures, when the mean free path becomes relatively large, quite a different state of things prevails, and the frictional drag on a solid becomes steadily less as the pressure is reduced.

There are two convenient ways of measuring the drag: (1) by balancing it against a known torque as in the somewhat elaborate gauge of Langmuir and Dushman (Phy. Rev. 1915); and (2) by the oscillation or swinging of a solid body and noting the damping effect.

LANGMUIR AND DUSHMAN'S "MOLECULAR" GAUGE.

This gauge depends upon the frictional drag between two horizontal parallel plates which are in relative motion. The lower plate is of aluminium and is set rotating in its own plane by means of a small high-speed induction motor (Fig. 15). The upper plate is of thin mica which

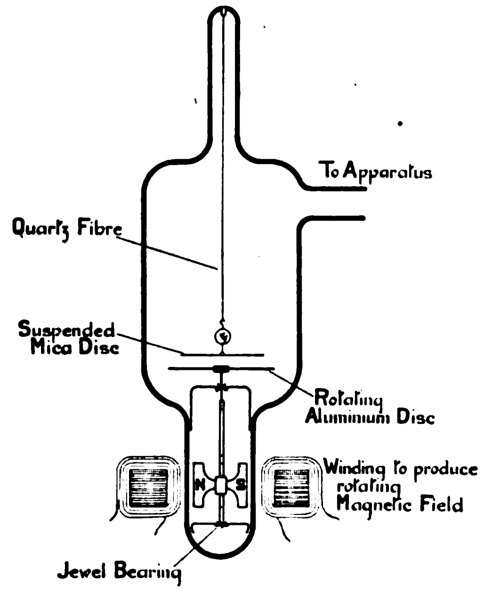

FIG. 15. Langmuir and Dushman "Molecular" Gauge.

is suspended by a quartz fibre bearing a mirror. The gas between the two plates tends to move with the rotating plate, and so a torque in the same direction is experienced by the suspended plate. The torque, which is balanced by the twist in the fibre, is proportional to the speed of rotation, to the pressure, and to the square root of M/T, where M is the molecular weight of the gas and T the absolute temperature, i.e., at constant speed and constant temperature the torque varies as $p\sqrt{M}$.

The readings of the instrument are thus affected by the nature of the gas. The gauge requires to be calibrated. The normal range is from 10^{-3} to 10^{-7}mm. Below 10^{-5}mm. the virtual absence of damping becomes troublesome, and there is a tendency for the mica disc to start swinging. It is not possible to eliminate entirely the effect of Foucault currents, and to sum up, the instrument is of small practical value for routine pressure measurement.

DECREMENT GAUGES.

The method of determining the viscosity of a fluid by measuring the

logarithmic decrement* of a pendulum swinging within it was devised long ago by Stokes. At moderate gas pressures the damping is independent of the pressure. At low pressures, however, the damping is a function of the pressure, and so measurements of the logarithmic decrement can be utilised for determining high vacua. The small damping at low pressures is readily displayed by the unanchored filament of an electric lamp, as compared with the pronounced damping when air is let into the lamp. A glass or quartz fibre bearing at its free end a small speck of iron, which can be set in vibration magnetically, shows the effect equally well. This device forms the basis of a number of decrement gauges.

It can be readily shown that the logarithmic decrement, λ, is proportional to the pressure p, and to the square root of the molecular weight M, the temperature being constant. If several gases are present, λ is proportional to the sum of a number of terms,

$$p_1\sqrt{M_1}+p_2\sqrt{M_2}+\text{———}$$

where p_1, p_2, ——— are the partial pressures, and M_1, M_2, ——— are the molecular weights of the various constituents.

The instrument requires to be calibrated. Proportionality is preserved

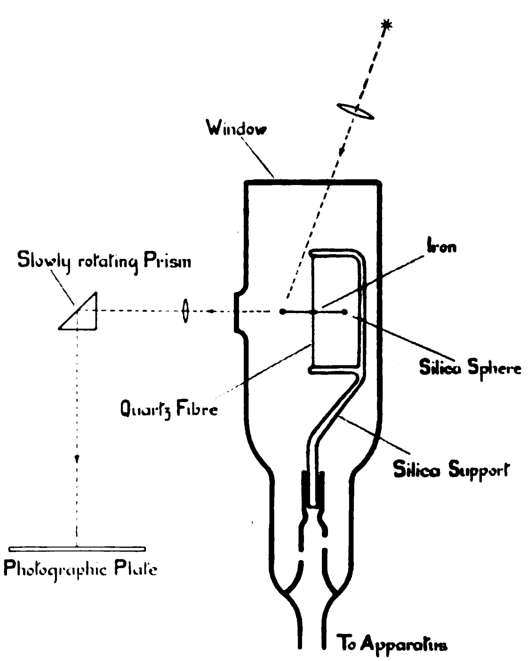

FIG. 16. King Decrement Gauge.

* The logarithmic decrement is the logarithm (to base e) of the ratio of two successive amplitudes.

over a working range from about 10^{-2} to 10^{-4}mm., the upper limit occurring when $p\sqrt{M} = 0.1$.

King (Proc. Phys. Soc., 1925) has developed a new type of decrement gauge in which the individual oscillations are photographed, so facilitating measurements of λ. A vertical quartz fibre is mounted under tension in a silica framework (Fig. 16), the tension thus being unaffected by temperature. Across the middle of the fibre and at right angles to it is a second quartz fibre, each end of which is fused into a sphere about 0.05 mm. in diameter. A minute piece of iron at the junction of the fibres serves to start the oscillations of the cross fibre, the damping of which is measured.

The oscillations are photographed by the optical system shown in Fig. 16, the fused ends of the cross fibre being utilised as convex mirrors of small radius of curvature. The right angled prism shown is slowly rotated so that the oscillation curves are spread over the photographic plate.

The advantages of the instrument are a long period (about 1 sec.), a definite plane of oscillation, a stable zero, indifference to external tremor, and freedom from metal parts.

The range of the instrument is from about 10^{-2} to 10^{-6}mm. pressure.

(4) Gauges Depending on Gaseous Thermal Conductivity.

Pirani Gauge.

Maxwell predicted long ago from the kinetic theory of gases that over a wide range of pressure the thermal conductivity of a gas should be nearly independent of the pressure. At low pressures, however, the conductivity is a function of the pressure. Pirani (Verh. d. Deutsch Phys. Ges., 1906,) was the first to turn this to account in a pressure gauge based on the rate at which heat is carried off from a hot wire by the molecules of the surrounding gas. The wire was a lamp filament which formed one arm of a Wheatstone bridge. The resistance of the filament varied with its temperature, which was controlled by the rate at which gas molecules collided with the hot filament and acquired energy in consequence. The rate of loss of heat is also controlled by the nature of the gas.

Pirani suggested two bridge methods for measuring the energy loss from the filament by (*a*) keeping the heating current constant and measuring the change in resistance as the pressure varied; or (*b*) keeping the temperature, and so the resistance constant and measuring the change in the energy supplied as the pressure altered.

G.E.C. Pirani Gauge.

Campbell (Proc. Phys. Soc. 1921) showed that Pirani's second plan of measuring the potential which must be applied to the bridge to keep the

temperature and resistance of the wire constant, was preferable, in that the calibration curves for different gases can be very simply correlated.

If V is the bridge potential for a pressure p in the gauge, and V_0 that for the lowest possible pressure, then Campbell found that the relation

$$\frac{V^2 - V_0^2}{V_0} = k.p.$$

is approximately true for gases and vapours over the range 0.1mm. to 0.001mm. For gases other than hydrogen the curves for different gases lie close together and may be taken as coincident for approximate measurements.

The British General Electric Co. have taken steps to popularize the use of ordinary tungsten lamps as Pirani gauges. In practice commercial 200-240 volt 40 watt Osram lamps are sufficiently alike to behave similarly. For these, bridge resistances of 20, 50 and 500 ohms. are recommended. V_0 is then about 3.5 volts, and k has the following values, p being measured in millimetres.

Gas.	k
H_2	0.0057
H_2O	0.0081
N_2, O_2, CO, CO_2	0.0097

The lamp may be connected to the bridge by twin flex several feet long without materially altering the calibration.

The Pirani gauge indicates the total pressure, i.e. the sum of all the partial pressures of any gases and vapours present. Thus any water vapour will be recorded. It is advisable to enlarge the sealing-off constriction normally present in the tungsten lamps as supplied. Otherwise, unless the system is exhausted and refilled with dry air several times, it is possible for a lamp to contain a measurable amount of water vapour even after exposure to a high vacuum and P_2O_5 for several days. Furthermore, such a constriction will check the rapidity of response of the gauge at low pressure.

No increase in sensitivity results from unduly raising the filament temperature. A temperature excess of 100°C. is sufficient. If the filament is raised to too high a temperature, say 1,000°C., the calibration will be impaired and should be repeated.

The Pirani gauge is capable of closely following changing pressures. It also lends itself particularly well to self-recording and automatic control devices.

(5) Ionisation Gauges depending on Gaseous Electrical Conductivity.

Buckley Ionisation Gauge.

It has long been known that the degree of ionisation produced in gases by the various ionising agent depends upon the pressure. Buckley (Proc. Nat. Acad. Sci. 2, 683, 1916) was the first to develop an ionisation gauge based on the pressure variation of the ionisation produced at low pressures by the electronic emission from heated metals. For this purpose he employed a bulb enclosing three V-shaped filaments of platinum foil mounted side by side parallel to one another and about 5mm. apart. One of the outer filaments acted as anode, the other outer filament was oxide-coated, and when raised to a red heat served as a Wehnelt cathode. The difference of potential between the anode and cathode was 100 volts or more, that is, well above the ionisation potential* of the gas.

The underlying theory of the instrument is that a stream of electrons from the cathode ionises the gas molecules to an extent depending on the number encountered. The central filament is kept negatively charged with respect to the cathode, so that it serves as a collector of the positive ions produced. When the pressure becomes so low that few electrons collide with more than one molecule, the rate of formation of positive ions will be proportional both to the number of electrons and to the number of residual gas molecules, i.e., to the pressure. Of these positive ions, a certain fraction will reach the collector depending upon the conditions, e.g. the dimensions, disposition and potentials of the electrodes, and the nature of the gas. In other words, if i_c is the ionisation current between the collector and the cathode, i_a is the electron current between the anode and the cathode then at low pressures under suitable conditions

$$p = k.\ \frac{i}{i_a}$$

where k is a "gauge constant" determined by the apparatus and the gas.

Buckley demonstrated the correctness of this relation for air over the pressure range 10^{-3} to 4×10^{-6}mm. He also investigated the effect on the value of k when hydrogen and mercury vapour were substituted for air.

Dushman and Found Ionisation Gauge.

Dushman and Found (Phys. Rev. 17, 7, 1921; 23, 734, 1924) in an extensive investigation on ionisation gauges, showed that the position of the collector was of importance in its effect both on the sensitiveness and

* Electrons will ionise gas molecules with which they collide, provided $\frac{1}{2}$ m.u² > Ve, where m is the mass, u the velocity, and e the charge associated with the electron, while V is the ionisation potential of the gas.

on the constancy of the relation between ionisation current and pressure. The charging up of the walls of the bulb is apt to introduce uncertainty into the readings, and of the various arrangements tried for eliminating this, Dushman and Found considered the most satisfactory was one in which the three electrodes were mounted concentrically. In this arrangement a spiral tungsten filament (cathode) was situated within a similar open spiral, which in turn was surrounded by a molybdenum cylinder.

It will be seen that the disposition of the electrodes of an ionisation gauge is practically that of a wireless valve, and indeed any small receiving valve may be utilised as a vacuum manometer. In practice there are two different arrangements which may be employed; in one the "grid" round the cathode acts as collector, and the outer "plate" acts as anode; in the other arrangement the roles are reversed. The former arrangement leads to greater simplicity of calibration, while the latter may be made the more sensitive. Thus in the first arrangement the positive ionisation current is measured between the filament (cathode) and the grid, which is then said to serve as an "internal collector," while in the second the ionisation current is measured between the filament and the plate, which then functions as an "external collector." In each case the electron emission is controlled by the temperature of the filament.

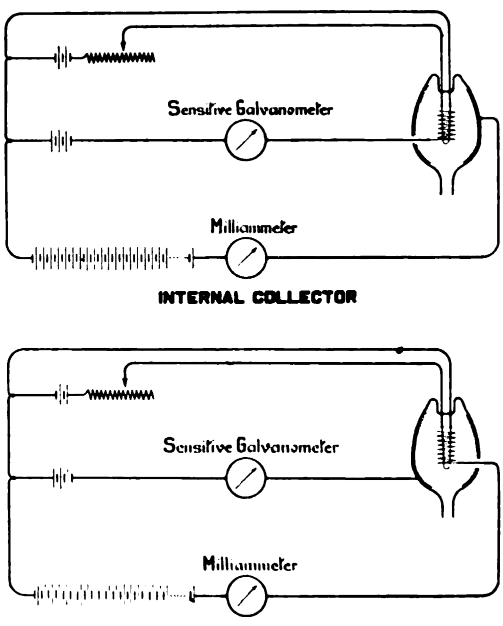

FIG. 17. Ionisation Gauge Circuits.

It may here be mentioned that the Research Laboratories of the British G.E.C. have put on the market a form of ionisation gauge in which within a bulb about the size of an ordinary vacuum lamp is mounted a V shaped tungsten filament (cathode) surrounded by a molybdenum wire cage. The inner surface of the bulb is silvered and serves as a third electrode.

The two circuits are shown for a G.E.C. gauge in Fig. 17. In either case the electron (or anode) current may conveniently be measured by some form of milliammeter, while the ionisation (or collector) current will need a galvanometer which, unless valve amplification is used, will need to be of high sensitiveness in the case of the lowest pressures.

If the electron emission is constant the internal collector arrangement has the advantage of affording proportionality between pressure and ionisation current, and being less affected by any lack of constancy in the applied potentials. The path of the electrons is definitely circumscribed by the outer plate, and so is independent of the current density and anode voltage. Thus at each pressure the electron emission and the ionisation which it produces will be proportional. This has the practical convenience of simplifying calibration of the gauge. The sensitiveness, which is readily controlled by the filament temperature, is, in general, inferior to that of the external collector arrangement, in some cases as low as one-third.

In the case of the external collector arrangement some of the electrons pass through the anode (grid) and traverse the space beyond, where they are repelled by the collector (plate) toward the anode. The effect occurs to a less extent with high electron emissions, which have the effect of building up a negative space charge between the anode and the outer collector. Thus, while for moderate emissions the electron and ionisation currents are approximately proportional, the latter increases less rapidly at high emissions. " *k* " is, in fact, no longer independent of the pressure, nor of the electron emission, and, moreover, varies considerably with the anode voltage.

Fig. 18 represents the calibration of Dushman and Found's gauge for argon at three different electron emissions, with an anode voltage of 250 and the external collector at —22 volts. It will be seen that at the lower pressures straight line relations are obtained which pass through the origin. At higher pressures the effect of ionisation by collision is evidenced by the sudden increase in the collector current. The effect is first shown in the case of the highest emission (25 m.a.) but is delayed as the electron current is decreased. It may be added that at 0.5 m.a. and 125 volts anode potential the linear relation between pressure and ionisation current is preserved at pressures as high as 4×10^{-2}mm.

As regards the lower pressure limit of the ionisation gauge, it is merely that imposed by the sensitivity of the instrument measuring the collector current. For an anode voltage of 250, a collector voltage of —22, and an

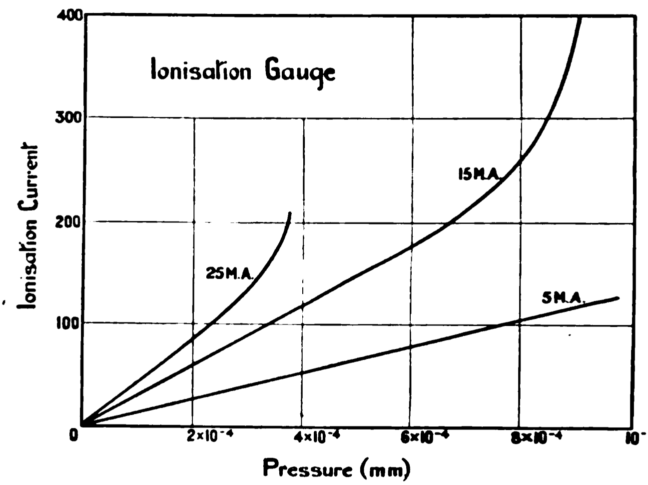

FIG. 18. Calibration of Ionisation Gauge.

electron emission of 25 m.a., the ionisation current in argon was of the order of 10^{-8} amp. at 7.5×10^{-8} mm. pressure. For the external collector arrangement both anode voltage and collector voltage are normally much less than are required when an internal collector is used. It should be added that the superior sensitiveness of the external collector arrangement renders it more suitable for the measurement of the lowest pressures. Calibration is not, however, quite so straightforward, and constancy of the applied potentials must be secured.

The selective response of the ionisation gauge to different gases necessitates caution in its use. It is of special value in standardised routine processes such as valve exhaustion, where the gauge and the connecting tubing can be subjected simultaneously to the same outgassing procedure as the vessel to be exhausted. Otherwise the gauge itself may assist either in " cleaning up " or lowering the vacuum.

In suitable circumstances the ionisation gauge readily lends itself to continuous recording or to the following of rapid changes of pressure. Deterioration of the tungsten filament occurs in the presence of mercury or water vapour, or oxidising gases. An accidental inrush of air will normally lead to burning out the heated filament. Dull-emitter cathodes, i.e. oxide-coated platinum filaments maintained at a dull-red heat, are very susceptible in their electron emission to both temperature and gas pressure, thus necessitating frequent and careful calibration. Furthermore, such cathodes are troublesome in their capacity for absorbing and emitting gases as the conditions are altered.

I am much indebted to Mr. W. H. Sewell for his effective assistance with the demonstrations.

OBITUARY.

Sir Hiram Shaw Wilkinson.—Sir H. S. Wilkinson, who died at his home at Tobermore, County Derry, on September 27th, in his 87th year, spent most of his career in the Far East. Born at Belfast on June 13th, 1860, the son of the late John Wilkinson of that city, he was educated at Queen's College, Belfast University, of which he became a B.A., and LL.D., and entered the British Consular Service in Japan as a Student Interpreter in 1864. In 1871 he was awarded a Studentship by the Four Inns of Court and was called to the Bar in 1872. Successive stages in his career were marked by his appointment as Vice-Consul at Nigata in 1877, Acting Assistant Judge at Shanghai in 1879, Crown Advocate in 1881, British Commissioner for the Settlement of Claims after the Canton Riots in 1883, Judge of H.M. Court for Japan in 1897, and Chief Justice of H.M. Court for China and Corea in 1900. He was knighted in 1903 and retired from the service in 1905. He was a D.L., and J.P. for County Derry and was High Sheriff in 1921. He had been a Fellow of the Royal Society of Arts since 1901.

NOTES ON BOOKS.

Papua of To-day, or an Australian Colony in the Making. By Sir Hubert Murray, K.C.M.G. London: P. S. King and Son, Ltd., 21*s*. net.

This volume is based on a wide experience of Papua dating from 1904 to the present time, during which period the author has successively held the offices of Chief Judicial Officer, Acting Administrator and Lieutenant-Governor, being appointed to the last-named office in 1908 soon after the transference of the Colony from the Imperial Government to the Commonwealth of Australia. The territory in question is the eastern portion of the island of Papua or New Guinea as distinguished from the middle portion—the mandated territory of New Guinea—and from the western portion or Dutch New Guinea.

Each of the outstanding questions which confront the administrator of tropical territories with native populations, *e.g.*, the consideration of racial origins, crime, land, labour, European settlement, exploration and native administration, are successively dealt with in one or more separate chapters. The primary importance of Papua to Australia and the Empire is strategic, in relation to the maintenance of a white Australia, but, beyond this, the territory has a special interest, arising out of the rather unique characteristics of the native population, for students of administrative problems in tropical dependencies. There is also the additional consideration for those responsible for the government of the Crown Colonies, that the Australian Commonwealth, while carrying on the best traditions of British Crown Colony administration, may naturally be expected to address itself in its own way to the various problems involved, and its method of handling these problems may convey suggestions of considerable value and interest to those engaged in the solution of somewhat similar problems elsewhere. The attitude of the Australian Administration in regard to the question of the purchase of land from natives and the encouragement of native plantations is of particular interest. One of the points made by the author is the value of applying anthropological knowledge—of course, with discretion and a constant reference to surrounding circumstances—to problems of native administration. A happy illustration of this occurs on p. 232. We will quote the author's own words:—

"It was necessary to have the natives vaccinated, and it was highly desirable, "for many reasons, that it should be done with their consent. At the same time "our natives have usually a great horror of the knife or anything which suggests "it, and further, it was to be expected that, even though the first few might submit "willingly enough, the pain and sickness which normally ensue on vaccination "would make the process vastly unpopular with the remainder. We wanted, "therefore, to put some view before them which would give an adequate explanation "of the reason for vaccination, and which would also recommend it to their favour- "able consideration. So we told them that there was a very dangerous and powerful "sorcerer in the west—that was the quarter from which the smallpox was expected "and that this sorcerer had conjured up a very bad sickness which might come "along at any moment. But, though the sorcerer was strong, the Government "was stronger, and would protect all who claimed its protection. A mark would "be put on the arm of all those who trusted themselves to the Government; the "sorcerer when he came would see the Government mark, would realize that he "was powerless, and would retire foiled and baffled to his home in the west. But "for those who would not receive the mark the Government could, of course, do "nothing.

"I have called this an extreme instance of the indirect methods, because we "worked through the natives' belief in sorcery, which, as a matter of fact, we "are doing our best to extirpate; but I still think that we are right, for we were "really doing no more than translate the theory of vaccination into a language "that a Stone Age savage could understand. Anyhow, whether we were right or "wrong, we were successful beyond our wildest dreams—the 'Government Mark' "became hugely popular, not only medically, but socially, and to be without a "mark was to confess oneself the veriest outsider. Fortunately, the sorcerer of "the west did not come; but if he had come we were ready for him."

The knowledge born of experience and judgment is evident in every chapter, and the value of the book is further enhanced by an easy style which makes it eminently readable. It can be recommended to everyone interested in the solution of the many difficult problems connected with the government of tropical dependencies by European races.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, OCTOBER 11..Brewing Institute of, at the Engineers' Club, 39 Coventry Street, W.1., 7.45 p.m. A Discussion on "The Present Season's Malts." To be opened by Messrs. W. S. Ward, W. J. Watkins, and H. W. Harman.

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Mr. S. E. Flack, Chairman's Address.

University of London, at University College, Gower Street, W.C. 5.p.m. Mr. R. J. Lythgoe, "The Special Senses." (Lecture III).

TUESDAY, OCTOBER 12..Aeronautical Engineers, Institution of, at the Junior Institution of Engineers, 39 Victoria Street, S.W.1., 6.30 p.m. Mr. M. L. Bramson, "Unsolved Aeronautical Problems."

Asiatic Society, 74, Grosvenor Street, W. 4.30 p.m. The Right Hon. Sir Charles Eliot, "The Worship of Amida in Japanese Buddhism, with some account of the origin and history of the Jodo and Shinshu Sects."

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. W. S. Burn, "Double Acting Oil Engines."

Metals, Institute of, at the Engineers' Club, Waterloo Street, Birmingham. 7 p.m. Mr. Arthur Spittle, Chairman's Address.

Petroleum Technologists, Institution of, at the Royal Society of Arts, John Street Adelphi, W.C.2., 5.30 p.m. Mr. A. Beeby Thompson, "The Significance of Surface Oil Indications."

Quekett Microscopical Club, 11, Chandos Street, W. 7.30 p.m. Dr. J. R. Leeson, "Microbes of Disease."

WEDNESDAY, OCTOBER 13..University of London, at University College, Gower Street, W.C.1. 5 p.m. Mr. R. J. Lythgoe, "The Special Senses." (Lecture IV).

At the School of Oriental Studies, London Institution, Finsbury Circus, E.C. 5 p.m. Sir E. Denison Ross, "Persian Poetry."

THURSDAY, OCTOBER 14..Mechanical Engineers, Institution of, Yorkshire Branch, at the Hotel Metropole, Leeds, 7.30 p.m. Mr. Fred Bland, "Rails, Points and Crossings."

Metals, Institute of, at 83, Pall Mall, S.W. 7.30 p.m. Mr. A. H. Mundey, Chairman's Address.

Mining and Metallurgy, Institute of, at Cleveland House, 225, City Road, E.C.1. 5.30 p.m.

University of London, at King's College, Strand, W.C.2. 5 p.m. Dr. C. Da Fano, "Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System." (Lecture II).

At London School of Economics, Houghton Street, Aldwych, W.C.2. 5 p.m. Professor G. Salvemini, "Economic, Social and Political Life of the Italian Communes in the Thirteenth Century." (Lecture II).

FRIDAY, OCTOBER 15..Metals, Institute of, at University College, Singleton Park, Swansea. 7.15 p.m. Captain L. Taverner, Chairman's Address.

University of London, at King's College, Strand, W.C.2. 5.30 p.m. Professor O. Jespersen, "Sex and Gender in English Historical Grammar." (Lecture I).

At University College, Gower Street, W.C.1. 5 p.m. Mr. R. K. Cannan, "Biological Oxidation Reduction." (Lecture II).

SATURDAY, OCTOBER 16..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mrs. H. M. Dunn, "Kashmir, the Country and its People."

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OF THE
ROYAL SOCIETY OF ARTS

CONTENTS:

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REGISTERED AS A NEWSPAPER.

: SOME CANTOR : AND OTHER LECTURES

Recently delivered before the Royal Society of Arts.

(Cobb Lectures.) Certain Fundamental Problems in Photography. Three Lectures. By T. Slater Price, O.B.E., D.Sc., F.R.S. (1924). Price 3s.

A Study of the Destructive Distillation of Coal. Three Lectures. By Edward Victor Evans, O.B.E., F.I.C. (1924). Price 2s.

Colloid Chemistry. Three Lectures. By Eric Keightley Rideal, M.B.E., Ph.D., D.Sc., F.I.C. (1924.) Price 1s. 6d.

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(Howard Lectures.) Motor Fuels. Three Lectures By Professor J. S. S. Brame, F.I.C., F.C.S. (1925.) Price 1s. 6d.

Radiological Research—a History. Three Lectures. By V. E. Pullin. (1925.) Price 2s.

The Inner Structure of Alloys. Three Lectures. By Walter Rosenhain, D.Sc., F.R.S. (1925.) Price 2s.

Copies of the above lectures can be obtained from the Secretary Royal Society of Arts.

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3856. VOL. LXXIV.

FRIDAY, OCTOBER 15th, 1926.

All communications for the Society should be addressed to the Secretary, John Street. Adelphi, W.C. (2.)

NOTICES.

TRUEMAN WOOD LECTURE.

The Trueman Wood Lecture will be delivered this year on October 27th, at 8 p.m., before the formal opening meeting of the Session on November 10th, owing to the fact that the lecturer has to return to New Zealand before the latter date. The lecture will be given by DR. ROBIN JOHN TILLYARD, M.A., Sc.D., D.Sc., F.R.S., F.L.S., Chief of the Biological Department of the Cawthron Institute of Scientific Research, Nelson, New Zealand, on "The Progress of Economic Entomology." SIR THOMAS HENRY HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, will preside.

DOMINIONS AND COLONIES SECTION.

The first meeting of the Dominions and Colonies Section will be held at 4.30 p.m. on Tuesday, November 2nd, when SIR STANLEY BOIS will read a paper on "The Importance of Rubber in the Economic and Social Progress of the World." SIR EDWARD ROSLING will preside.

Tea will be served in the library at 4 p.m.

REPRINT OF CANTOR LECTURES.

The Cantor Lectures on "Coal Ash and Clean Coal," by R. Lessing, Ph.D., M.I.Chem.E., have been reprinted from the *Journal*, and the pamphlet (price 2s.) can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A full list of lectures which have been published separately and are still on sale can also be obtained on application.

ROYAL SOCIETY OF ARTS.

REPORT ON THE SOCIETY'S EXAMINATIONS, 1926.

INCREASE IN NUMBERS OF CANDIDATES.

Up to the year 1914 the Society's Examinations were held only once a year—immediately before Easter. It was found, however, that this date was inconvenient for a great many institutions whose classes continued to a later date in the year, and in 1915 a second series, held just before Whitsuntide, was instituted. The wisdom of this step was immediately proved by the large number of candidates who entered at the later dates, and now the number of the Whitsuntide entries is approximately double that of the Easter entries.* Originally the Examinations were intended for students attending classes in evening institutions, but since 1920 a steadily increasing number of day schools have been entering their students, and for some time past representations have been made to the Council that it would be desirable to hold a third series of examinations in July, the month in which the school year, as a rule, closes.

After very careful consideration of the question, the Examinations Committee recommended the Council to adopt the suggestion. At first it was proposed to hold the third series of examinations this year only in the elementary and intermediate stages of the following subjects:—Arithmetic, Book-keeping, English, Economic Geography, Economic and Social History, French, Shorthand, Typewriting, and Commerce. It so happened, however, that the General Strike broke out early in May, and made it impossible to hold many of the examinations which had been arranged for the Whitsuntide series. In order not to disappoint a large number of candidates who had been preparing for these examinations, it was then decided to enlarge the July programme very considerably, and examinations were held in all three stages in nearly all the subjects of the syllabus.

Next year it is proposed to hold, in addition to the Easter and Whitsuntide series, two sets of examinations in July—one based on the old syllabuses and designed for evening students, the other for students of day schools, based on syllabuses which have been specially prepared by the Examinations Committee.

The institution of the July examinations has resulted in a marked increase in the total number of candidates. The number of papers worked this year is 83,246, as compared with 70,638 in 1925. The diagram on page 1066 shows how the numbers have grown since 1900, when the total was under 10,000. This remarkable growth is a source of great satisfaction to the Council, giving evidence, as it does, of the high value attached by those engaged in commercial education to this branch of the Society's work.

* In 1925 the numbers were 26,071 and 44,567.

SOME STATISTICS.

The table on page 1067 gives full particulars of the numbers of candidates in each subject of examination, and of those who obtain first-class or second-class certificates, or fail. It is not proposed to give in detail the percentages of successes and failures for each subject, but in view of the fact that the pass mark in Stage II was raised this year from 40% to 50%, it may be of some interest to note a few general statistics. Comparing this year's results in all subjects of examination with those of 1925 we find that:

64.71 passed and 35.29 failed in 1926.
67.24 ,, 32.76 ,, 1925.

If the figures are further analysed we get the following results:

Stage III (Advanced).	1926	1925
1st class	12.93%	12.56%
2nd class	45.23	45.28
Fail	41.84	42.16
Stage II (Intermediate)		
1st class	18.75	13.18
2nd class	46.53	56.87
Fail	34.72	29.95
Stage I (Elementary).		
Pass	65.87	67.13
Fail	34.13	32.87

It will be seen that in Stage III the percentages for the two years are very nearly the same. In Stage II it is satisfactory to notice that there has been a distinct increase of over 5½ per cent. in the number of first-classes. The decrease of almost 10 per cent. in the number of second-class certificates was probably to be expected as a result of raising the pass mark from 40 to 50 per cent. The proportion of second-classes in this Stage is now very close to that in Stage III. It is believed that the change, which, by making the pass mark uniform in all three Stages, removes an anomaly in the conditions of the examination, is more than justified and will meet with general approval.

AGES OF MEDALISTS.

The ages of candidates used to be printed in the results, but this practice was discontinued a good many years ago because, in accordance with a well-

known weakness of their sex, it was often impossible to elicit from women candidates any information more definite than that they were "adult." It may, however, be of interest to note the ages of some of the medalists of this year. The first place out of 309 candidates in Arithmetic (Stage III) was obtained by Charles Thomas Beaumont, of Peckham L.C.C. Central School, aged 15. The first place out of 3,577 candidates in Book-keeping (Stage III), was obtained by Lloyd Berry, of Pitman's School, London, aged 16. In Book-keeping (Stage II), Frank G. Ross of Southend, aged 15, was bracketed 11th out of 8,601 candidates; in Commerce (Stage II), Ella Tolson, of Huddersfield Technical College, aged 16, was first out of 749 candidates; in English (Stage II), Joan Ellwood, of Tavistock School, Croydon, aged 14, was bracketed fourth out of 2,167 candidates; in French (Stage II), Ivan L. Estwal, of Knight's Commercial College, Wolverhampton, aged 16, was sixth out of 2,601 candidates; and in Typewriting (Stage II), Amy F. Ralph, of Cusack's College, London, aged 14, was fourth out of 3,020 candidates.

SOME COMMON FAULTS OF CANDIDATES.

In last year's Report attention was drawn to some of the commonest faults in candidates. Examiners comment on these faults year after year, and year after year the faults continue to reappear. This, no doubt, is only what might be expected, for, although the examiners and the teachers may remain the same, the candidates do not, those of this year being at practically the same stage of development as those of 1925. At the risk of appearing to use vain repetition, therefore, it is proposed once again to refer to these faults. For repetition is not always vain. A certain examiner, who had been asked to examine candidates for junior county scholarships, in a northern shire, found that the children were hopelessly mixed as to the meaning of "lay" and "lie." For several years he set questions on the subject, and by the end of his term of office, all the children in the county had mastered the two verbs. Bearing this lesson in mind, one may perhaps once more mention some of the commonest faults in candidates:

(1). A great many candidates fail because they will not, or cannot read the questions intelligently, and they will give answers to questions which are not set. Probably the best way to correct this fault is for teachers to set papers frequently and to drill their pupils rigorously into considering carefully the wording of the questions before they start writing the answers.

(2). Handwriting is often very bad. Any candidate ought to be able to write legibly—more is not expected—but some of the scripts that are handed in are an insult to the examiner and a disgrace to the examinee.

(3). Spelling often leaves much to be desired even in candidates at the Advanced Stage. Bad spelling is a sign of illiteracy, and has to be punished severely.

(4). Many candidates are extremely careless as to the way in which they set forth their answers, some even going so far as to scatter parts of the answer to one question over several pages amongst the answers to others. Neatness and method are not fads—they are positive virtues.

REPORTS OF EXAMINERS.

The Examinations were held at three periods, March, May and July. In March the number of entries was 27,160, in May, 47,594, and in July, 14,253. The papers worked were divided among the three Examinations as follows :—

	March.	May.	July.	Total.
Advanced Stage	2,339	4,889	1,726	8,954
Intermediate Stage	8,096	14,249	7,522	29,867
Elementary Stage	15,426	17,145	11,854	44,425

In addition to the 83,246 papers worked in the written examinations, 656 candidates presented themselves for the *viva voce* Examinations in Modern Languages.

The subjects of Examination this year were :—

Arithmetic.
English.
Book-keeping.
Shorthand.
Typewriting.
Economic Geography.
Economic and Social History.
Economic Theory.
Précis-writing.
Commercial Correspondence and Business Knowledge.
Commercial Law.
Company Law.
Accounting.
Banking.
Costing.
Foreign Exchange.
Commerce.
Railway Law and Practice.
Railway Economics.
Shipping Law and Practice.
Stock Exchange Law and Practice.
Insurance Law and Practice.
Advertising and Salesmanship.
French.
German.
Italian.
Spanish.
Russian.
Dutch.
Portuguese.
Swedish.

Arithmetic.—The total number of papers worked in all three stages this year was 10,773, as compared with 7,728 papers last year. Of the 309 papers worked in Stage III, 30 papers gained first-class certificates, 96 papers gained second-class certificates, and 183 failed to reach the pass standard. The examiner remarks that, while a number of excellent papers were sent up, especially at the March examination, including one paper which was awarded full marks, there continues to be a high percentage of failures in this stage.

In Stage II, out of 2,712 papers sent in, 635 papers obtained first-class certificates, and 1,109 papers obtained second-class certificates, the number of failures being 968. Although there were a fair number of admirable papers, well written and with the working neatly arranged, the examiners report too large a percentage showing inaccuracy and poor work. Attention is drawn to the necessity of shewing the working in all cases, and to the value of making greater use of " practice " methods, and of decimals, instead of vulgar fractions, for working out results.

In Stage I, out of a total of 7,752 candidates, 5,617 passed and 2,135 failed. The results in this stage were on the whole fairly satisfactory, and in the July examination 33% of the candidates obtained 70% marks or more. In Part I (mental arithmetic), some of the candidates did not understand that no written calculations are permissible, and that the result must not be written down in two steps. The examiners also emphasize the importance of instructors teaching their pupils to think, e.g., to consider in each particular case whether the use of decimals or vulgar fractions will be the more convenient method, and to safeguard themselves against arriving at absurd conclusions by making a preliminary rough calculation of the required result. As in Stage II, candidates in this stage do not always appreciate the advantage they derive from shewing their working in a neat and legible manner.

English.—The number of candidates in this subject was 7,189, as compared with 5,973 last year. Of the 463 candidates in Stage III, 31 obtained first-class certificates, 235 obtained second-class certificates, and 197 failed. The examiner says in his Report: " the impression left by the papers worked in Stage III is that the really good candidates are few, and so are the really bad; of the candidates between these, very many are not up to the standard of an advanced stage examination. Too many immature candidates enter and some of them have not yet outgrown childishness of thought and expression, while of the more mature many expect to take the examination in their stride without preparing for it."

The number of candidates in Stage II was 2,167, of whom 163 obtained first-class and 1,065 obtained second-class certificates, while 939 failed. A similar criticism is made in regard to Stage II that " too many of the candidates enter for the examination without an adequate grounding in the understanding and use of English." In a summary of a passage from an address by Mr. Baldwin to the Classical Association, the speaker's reference to the " sentences of the ancients, clean run like athletes and fit for their work, as compared with the prolapsed and slovenly figures of much of our own diction," is transformed by one candidate, into " the writers of Greek and Latin were clean-limbed and fit, unlike our writers of to-day, who owing to their slovenly figures cannot write their thoughts," while the speaker's description of how during his first election he found mental refreshment in reading the odes of Horace before

going to bed after having to listen to comic songs in public houses, which was part of the election routine of those days, is summarised by another candidate as follows: "at the first election I fought I was expected to sing comic songs in public houses, but I never was really successful until I started reading old poems by good authors." Such misconceptions as to the whole meaning of a passage, or, as is frequently the case, of the meaning of the question set, are much too frequent, and the examiner emphasizes the primary necessity of teaching children "to think clearly and to say clearly what they think."

In Stage I, out of 4,559 papers worked, 2,750 obtained sufficient marks to pass, the failures numbering 1,809. The examiner remarks upon the extraordinary difference between the papers sent in by the candidates of some centres—neatly written, well expressed, showing knowledge of the prescribed books as well as natural intelligence and giving in every way evidence of careful teaching—and the majority of the papers which exhibited the reverse characteristics. He is of opinion that if teachers could cultivate in children at this early stage a habit of reading the works of good authors, most of the deficiencies shown at this and later stages would disappear.

Book-keeping.—The number of candidates taking this popular subject continues to increase, being 23,407 this year, as compared with 20,928 in 1925. In Stage III, out of 3,577 candidates, 410 obtained first-class certificates, 1,581 obtained second-class certificates, and 1,586 failed. In Stage II out of 8,601 candidates, who sat for the examination, first-class certificates were awarded to 1,195, second-class certificates to 4,901, and 2,505 failed.

The examiner reports that further improvement in the best papers was noticeable in Stages III and II, reflecting credit on both teachers and candidates, and that in general the standard of work was well up to the average.

In Stage I, 11,229 candidates presented themselves for examination. Of this number, 6,737 passed and 4,492 failed. The examiner states that while there was an increase in the percentage of passes, there were comparatively few examples of work of a high standard. He also calls attention to the need of improved style and neatness both in the exercises and written questions.

Economic Geography.—The number of candidates who took this subject was more than double last year's figure, i.e., 1,295 as compared with 626. Generally speaking, there was a distinct and satisfactory improvement in the papers of all three Stages, though the examiner notes deficiencies in certain directions, e.g., the failure to understand the meaning of words such as "analyse," and of geographical terms constantly used in examination questions, an inability to restrict the scope of the answer to the question asked, and to make proper use of the knowledge actually possessed. The regular exercise of the pupils in written work is recommended as the only way to overcome these defects.

In Stage III, out of 70 candidates who took the examination, 11 qualified for

first-class certificates, 36 qualified for second-class certificates, while 23 failed. In Stage II, 414 candidates sat for the examination, first-class certificates being awarded to 52, and second-class certificates to 236, while 126 candidates failed. The examiner comments upon the marked improvement in the work done at the May and July examinations in Stages III and II, especially in the drawing of sketch maps. In Stage I there were 811 candidates, and of these 576 passed and 235 failed. The examiner observes a great improvement in most directions, but the fact that the sketch maps often shew much more knowledge than candidates in this Stage succeed in expressing in their written answers, suggests that care should be taken to ensure that pupils thoroughly understand as well as memorise the information contained in maps.

Shorthand.—There were 17,091 entrants for the examination in this subject in 1926, as compared with 14,691 last year. In Stage III there were 1,417 candidates, of whom 136 obtained first-class certificates, 365 obtained second-class certificates, and 916 failed. The work in the March and May examinations was quite up to the standard of previous years, and in the July examination shewed a further improvement, the percentage of candidates gaining certificates being much above the average. In Stage II, out of 7,475 candidates who sat for the examination, 1,547 obtained first-class certificates, 2,161 obtained second class certificates and 3,767 failed. The examiner states in his report that " the work in this Stage was on the whole good, and in the July examination in the case of those papers which passed a marked improvement was noticeable in both the style of the notes and in the transcripts." In Stage I there were 8,199 candidates of whom 4,879 passed and 3,320 failed. There appears to be considerable weakness in the candidates at the lower end of this Stage. The examiner reports that, while " the general standard of work in the March examination at both speeds was on the whole good, in the May examination the transcripts of the majority of those who failed were decidedly bad. The shorthand notes were crude and the spelling in many cases very weak." In regard to the July examination he adds : " the 50 words per minute papers were very poor. Several candidates seemed to have no idea of setting out a letter properly, and in some cases the writing was atrocious."

A very pleasing feature of the examination was the striking success obtained by blind candidates from the Royal Normal School and Worcester College for the Blind, who had been instructed in the use of the Braille system of shorthand and entered the examination for the first time this year. All these candidates passed in a most creditable manner. The transcripts, which were typewritten, were very good, and the typing itself was really excellent. The examiner says in his Report : " in each case the examination was held under exactly the same conditions as those prevailing at other centres. The results are highly satisfactory, and great praise is due to both students and teachers. In view of the success which has been achieved on the present occasion, it is to

be hoped that further inducements to take up the Braille system of shorthand will be held out to those who have been so sadly afflicted and that increased facilities will be afforded them for attending the Royal Society of Arts examinations in the future."

Typewriting.—The candidates taking this subject numbered 8,257 as compared with 7,174 last year. In Stage III there were 756 entrants, of whom 160 gained first-class certificates, 442 gained second-class certificates, and 154 failed. In Stage II, out of 3,020 candidates 993 obtained first-class certificates, 1,556 obtained second-class certificates, and 471 failed. In Stage I there were 4,481 papers worked, of which 3,529 qualified for a pass, and 952 failed to reach the pass standard.

The examiner reports: "the standard attained is generally very satisfactory, the work being both accurate and well arranged. The time tests were free from omissions, transpositions and the like. The March and May failures may be attributed to inadequate speed, examinees being unable to execute sufficient work to earn the minimum pass marks. The percentage of really weak papers in all stages was small. The most noticeable faults were: typing too near the bottom of the paper; lack of knowledge as to the setting out of verse; omission of the date in letters, and want of acquaintance with legal abbreviations."

Economic and Social History.—Last year's figure for candidates taking this subject was nearly doubled in 1926—the numbers being 83 and 159 respectively. In Stage III, out of 19 entrants, first-class certificates were awarded to 7 candidates, second-class certificates to 10 candidates, and 2 candidates failed. There were a number of very meritorious papers, and the remainder, apart from the failures, reached a satisfactory standard of knowledge. The examination in Stage II was taken by 52 candidates, of whom 5 obtained first-class certificates, 40 obtained second-class certificates, and 7 failed. Generally speaking, a satisfactory level of performance was reached, and accurate and sufficient knowledge shewn. In Stage I there were 88 candidates, of whom 58 passed and 30 failed. While there was a good deal of work of weak calibre in this Stage as shewn by the rather large number of failures, about two-thirds of the candidates attained a reasonable standard of knowledge and intelligence.

Economic Theory.—There were 555 entries for this subject, as compared with last year's total of 453. In Stage III, out of 196 papers worked, first-class certificates were awarded to 20, and second-class certificates to 137, the number of failures being 39. Although a few meritorious papers were submitted, including one of exceptional merit, which gained full marks, there was otherwise not very much work of outstanding quality, most of the candidates to whom

first or second-class certificates were awarded only just reaching the necessary standard for those distinctions. The examiner says in his report: "it is still necessary to repeat as in previous years that candidates attempt this Stage unsuccessfully, who might probably have done better had they not aspired beyond the Intermediate Stage of the examination."

In Stage II 359 candidates sat for the examination. Of this number, 32 obtained first-class certificates, 256 second-class certificates, and 71 failed. At this Stage a better general level of knowledge was attained and a good proportion of the papers were marked by a solid and sufficient performance.

Précis-writing.—This subject was taken by 150 candidates as compared with 130 last year. Out of 37 candidates in Stage III, 5 candidates obtained first-class certificates, 21 obtained second-class certificates and 11 failed. In Stage II there were 113 candidates, of whom 18 qualified for first-class certificates, 55 qualified for second-class certificates, and 40 failed. The examiner reports that the work was on the whole a little better than last year. The results, however, point to the desirability of giving pupils more practice in this exercise. The ability to pick out quickly the salient points in a proposition or narrative and to reduce them to writing in a balanced and logical sequence is one of the most useful accomplishments, and it is suggested that more attention should be given to its cultivation.

Commercial Correspondence and Business Knowledge.—The number of entries for this subject was 3,909, as compared with 3,968 last year. The slight reduction is doubtless due to the fact that this subject is to be discontinued after this year, the really important elements in it being included in the examination in "Commerce." In Stage III, 111 papers were worked, first-class certificates being awarded to nine, and second-class certificates to 38, while 64 failed. In Stage II, out of 1,111 entries, 84 candidates obtained first-class certificates, 479 obtained second-class certificates, and 548 failed. In Stage I the number of candidates was 2,687, of whom 1,732 passed and 955 failed.

Commercial Law.—This subject was taken by 577 candidates, as compared with 489 in 1925. In Stage III the entries numbered 229, of whom 64 qualified for first-class certificates, 125 qualified for second-class certificates, and 40 failed. The examiner says in his report on the March examination: "practically all the candidates shewed a sound knowledge of the principles of Commercial Law, and most of the papers were characterised by accuracy, adequacy and relevancy," and with reference to the May examination, he adds: "there was little irrelevancy, and though the percentage of failures was greater than usual, it was evident that most of the candidates had received careful and able instruction." In Stage II there were 348 candidates, first-class certificates

being awarded to 181 candidates, second-class certificates to 108, while 59 failed. The exceptionally large proportion of first-class certificates is attributable to the very high standard of the papers sent in at the May examination, in regard to which the examiner reports: "this is one of the best set of scripts the examiner has ever marked. The answers were accurate, informative and intelligent." He, however, finds it necessary to call attention to the deplorable writing and slovenly arrangement of the work of some candidates, but adds: "fortunately, the majority of candidates did not forget that this was a commercial examination, and therefore wrote legibly and accurately."

Company Law.—The candidates entering for this subject numbered 318, as compared with 308 last year. In Stage III, 90 candidates sat for the examination, and of these 20 obtained first-class certificates, and 62 obtained second-class certificates, the number of failures being 8. The papers were generally satisfactory and there were few failures, but the knowledge shewn lacked the essential detail which is expected from candidates in the Advanced Stage. In Stage II, out of 228 candidates who took the examination, first-class certificates were awarded to 123, second-class certificates to 81, while 24 failed. The examiner comments upon the general weakness in the knowledge of the law relating to private companies and to the conduct of and procedure at company meetings. "Both of these topics," he says, " are of great importance from the commercial point of view, since probably some 70 per cent. of limited companies are private companies, and, further, companies can usually only act by and at meetings. Questions which had no reference to these subjects were as a rule satisfactorily answered, but there was a general absence of accurate knowledge."

Accounting.—The number of candidates in this subject was 555, of whom 59 obtained first-class certificates, 253 obtained second-class certificates, and 243 failed. The leading papers were excellent, and gave evidence of serious and intelligent study, but apparently a good many candidates had failed to study the law of partnership and executorship, which has recently been added to the syllabus.

Banking.—25 candidates entered for this subject, of whom 2 obtained first-class certificates, 13 obtained second-class certificates, and 10 failed. The book-keeping side appears to have been neglected by several candidates.

Costing.—There were only 73 entries for this examination this year, as compared with 100 last year, when the subject was introduced into the examination syllabus for the first time. It is, however, satisfactory to note that the standard of knowledge this year shewed a distinct improvement, 5 first-class

certificates being awarded as compared with only 1 first-class certificate last year, and the total percentage of successful candidates being 64% as compared with 31% in 1925. The examiner reports that many papers shewed a lack of knowledge of workshop conditions and recommends that more attention should be paid to the important subject of the machine-hour rate of charging on-cost.

Foreign Exchange.—There were 28 entries in this subject as compared with 38 last year. In Stage III, out of 19 candidates, 8 obtained first-class certificates, 10 obtained second-class certificates and 1 failed. In Stage II there were 9 candidates, first-class certificates being awarded to 4 candidates, second-class certificates to 4 candidates, while 1 candidate failed. Some very good papers were worked in both stages.

Commerce.—There was again a considerable increase in the number of candidates taking this examination—1,717 as compared with 1,223 last year—and it is expected that the popularity of this important subject will continue to grow. In Stage III, out of a total of 218 candidates, 28 qualified for first-class certificates, 127 for second-class certificates, and 63 failed. The examiner states that there was in many cases carelessness in reading the questions, and a tendency on the part of many candidates to answer questions by tabulated lists, evidently learnt off by heart from the text-book or teacher, without taking the trouble to add anything at all of their own. Iu Stage II there were 749 candidates of whom 44 obtained first-class certificates, 439 obtained second-class certificates, and 266 failed. In this Stage there was an unusually small proportion of first-class papers, and the work on the whole was moderate. There was a marked tendency to answer questions other than those asked. In Stage I, out of 750 candidates, 519 passed and 231 failed. While the work done in the March examination was rather poor it was much better in the May and July examinations. In reference to this Stage also the examiner remarks that "it cannot be too clearly impressed upon pupils that it is desirable to answer the questions as asked by the examiner, and not as expected or as recast by the pupil."

Railway Law and Practice.—The candidates taking this subject numbered 44, as compared with 49 in 1925. First-class certificates were awarded to 7, second-class certificates to 25, and 12 failed. The work done was on the whole very creditable, but the examiner calls attention to the inability to state clearly a general case, and also to the failure to support statements of law by quoting decisions in well-known cases.

Railway Economics.—There were 17 entries for this subject as compared with 25 entries last year. Five candidates obtained first-class certificates, 8

candidates obtained second-class certificates, and 4 candidates failed. These results shew a quite satisfactory standard of performance in this subject.

Shipping Law and Practice.—This subject was taken by almost the same number of candidates as last year, the figures being 38 and 39 respectively. First-class certificates were awarded to 6 candidates, second-class certificates to 22 candidates, while 10 candidates failed.

Stock Exchange Law and Practice.—The number of candidates who sat for this examination was 36, as compared with 33 last year. In Stage III, out of 17 candidates, 4 gained first-class certificates, 10 gained second-class certificates, and 3 failed. In Stage II, in which there were 19 entries, the same number of first-class and second-class certificates were awarded as in Stage III, and 5 candidates failed. The standard of knowledge in this subject was not very high, and the examiner comments upon the weak spelling and orthography of some of the candidates.

Insurance Law and Practice. There were 10 candidates in this subject as compared with 9 candidates last year. First-class certificates were awarded to 2 candidates, second-class certificates to 6 candidates, and 2 candidates failed. The examiner considers the results satisfactory, and says: "one of the papers was of outstanding merit and showed a thorough grasp of the subject. As in previous years, it appears that the practical side is better understood than the legal side. Composition and handwriting were mainly good."

Advertising and Salesmanship.—The number of candidates was 40, a slight increase as compared with 1925, when the figure was 35. Of these, 8 obtained first-class certificates, 24 obtained second-class certificates, and 8 failed. Advertising appears to be one of the few fields where the demand for men and women possessing a sound knowledge of the principles of their business greatly exceeds the supply, and it is a little disappointing that the number of candidates entering for this subject remains so small.

MODERN LANGUAGES.

French.—The number of candidates entering for this subject continues to increase in a very healthy way, the total for 1926 being 5,747, as compared with 4,786 in 1925. An even more satisfactory point is that the standard of the work, already very high, is fully maintained if not even raised. In Stage III, of 445 candidates, 95 obtained first-class certificates, 248 obtained second-class certificates, and 102 failed. The examiner comments on the excellence of many of the free compositions—a most important part of the examination. It would, indeed, appear that French is taught better in our schools than any other subject.

In Stage II there were 2,061 candidates, of whom 458 obtained first-class certificates, 1,113 obtained second-class certificates, and 490 failed. Here again the free compositions were good, and the answers to the questions in the commercial section particularly satisfactory. The literary questions on the other hand were poorly done.

In Stage I there were 3,241 candidates, of whom 2,368 passed and 873 failed.

Both teachers and candidates are strongly advised to read carefully the examiner's reports, which will be found to contain much useful advice for serious students of French.

German.—The number of candidates entering for German shows a slight decrease as compared with 1925, the totals being respectively 410 and 429. In Stage III, there were 50 candidates, of whom 8 obtained first-class certificates, 24 obtained second-class certificates, and 18 failed. Here, as in French, the examiner reports that the commercial questions were answered much more satisfactorily than the literary questions.

In Stage II of 161 candidates 32 obtained first-class certificates, 81 obtained second-class certificates, and 48 failed. A certain number of these entrants had a very poor knowledge of German grammar, and should have contented themselves with entering for Stage I; but the examiner reports a very distinct improvement in the free compositions.

In Stage I, of 199 candidates, 118 passed and 81 failed.

Italian.—The total number of candidates in Italian was 88. In Stage III, there were 14, of whom 5 obtained first-class certificates, 8 obtained second-class certificates, and 1 failed. In Stage II, of 28 candidates 10 obtained first-class certificates, 16 obtained second-class certificates, and 2 failed. In Stage I of 46 candidates, 41 passed and 5 failed. The examiner reports a distinct improvement on the work of last year, especially in Stage II.

Spanish.—There was a satisfactory increase in the number of candidates taking Spanish, the total being 707, as compared with 590 in 1925. In Stage III, of 109 candidates, 11 obtained first-class certificates, 78 obtained second-class certificates, and 20 failed. Here, in contra-distinction to French and German, the examiner reports that the answers to the literary questions are generally better than those in the commercial section, and the candidates, as a rule, appear to be well read, especially in Spanish fiction.

In Stage II there were 225 candidates, of whom 20 obtained first-class certificates, 177 obtained second-class certificates, and 28 failed. Speaking generally, the essays in Spanish were too short, but some of the work sent in was excellent.

In Stage I, of 373 candidates 332 passed and 41 failed. Here the essays, as a rule, were well done, and the papers showed an improved knowledge of Spanish idioms and vocabulary.

Russian.—The number of entries this year, 18, is exactly the same as in 1925. In Stage III, of 2 candidates one obtained a first-class certificate and one a second-class certificate. In Stage II there were 6 candidates of whom one obtained a first-class certificate, 4 obtained second-class certificates, and 1 failed. In Stage I there were 10 candidates, of whom 8 passed and 2 failed. The standard reached here was considerably higher than usual.

Portuguese.—There were 8 candidates in all in Portuguese. In Stage III, of 4 candidates one obtained a first-class certificate, and 3 obtained second-class certificates. In Stage II, of 4 candidates 1 obtained a first-class certificate, and 3 obtained second-class certificates.

Swedish.—In Swedish, 5 candidates entered in Stage II, and of these 3 obtained second-class certificates, and 2 failed.

ORAL EXAMINATIONS.

The results of the Oral Test which is now compulsory for all candidates in the Advanced Stage of French, German, Spanish, and Italian were well above the average ; although there were 21 fewer candidates than in 1925, there were 20 less failures this year. An important part of the Oral Test is the taking down of a passage dictated in the foreign language by the examiner, and in the past this has been a source of great weakness with many candidates. It is gratifying to be able to state that the examiners now report a very great improvement in this branch of the examination.

GROUP CERTIFICATES IN COMMERCIAL SUBJECTS.

The increase, noted in last year's report in the number of candidates entered from Higher Elementary Schools, and also the new Central Day Schools set up under various Education Authorities, has been well maintained. Most of

ORAL EXAMINATIONS HELD DURING 1926.

Subject.	No. of Examination Centres.	No. of Examiners.	No. of Candidates examined.	Passed with Distinction.	Passed.	Failed.
French ...	52	37	485	95	308	82
German ...	9	9	52	12	29	11
Spanish ...	12	11	105	23	65	17
Italian ...	3	3	14	8	5	1
	76	60	656	138	407	111

these candidates take a number of subjects qualifying for the Group Certificate in Elementary Commercial Subjects. To gain this special certificate candidates must pass in Arithmetic, English and two other subjects within three consecutive years, but it is satisfactory to find that many pupils from Day Schools pass in the necessary subjects in one year. In view of the fact that a fairly high standard is maintained in the Elementary Stage (it is by no means a first year's examination), the results at these Schools give evidence of really excellent preparation.

Group Certificate Prizes.

In order to encourage students to take up groups of subjects, the Council decided in 1924 to offer £200 in prizes for candidates who completed group certificates in Commercial Subjects in the Advanced and Intermediate Stages in 1925; the prizes were then won by candidates who all obtained a high percentage of marks in the respective subjects.

In 1926, fourteen prizes of £10 each were offered in the Advanced Stage and twelve prizes of £5 each in the Intermediate Stage.

The qualification for Group Certificates is as follows:—

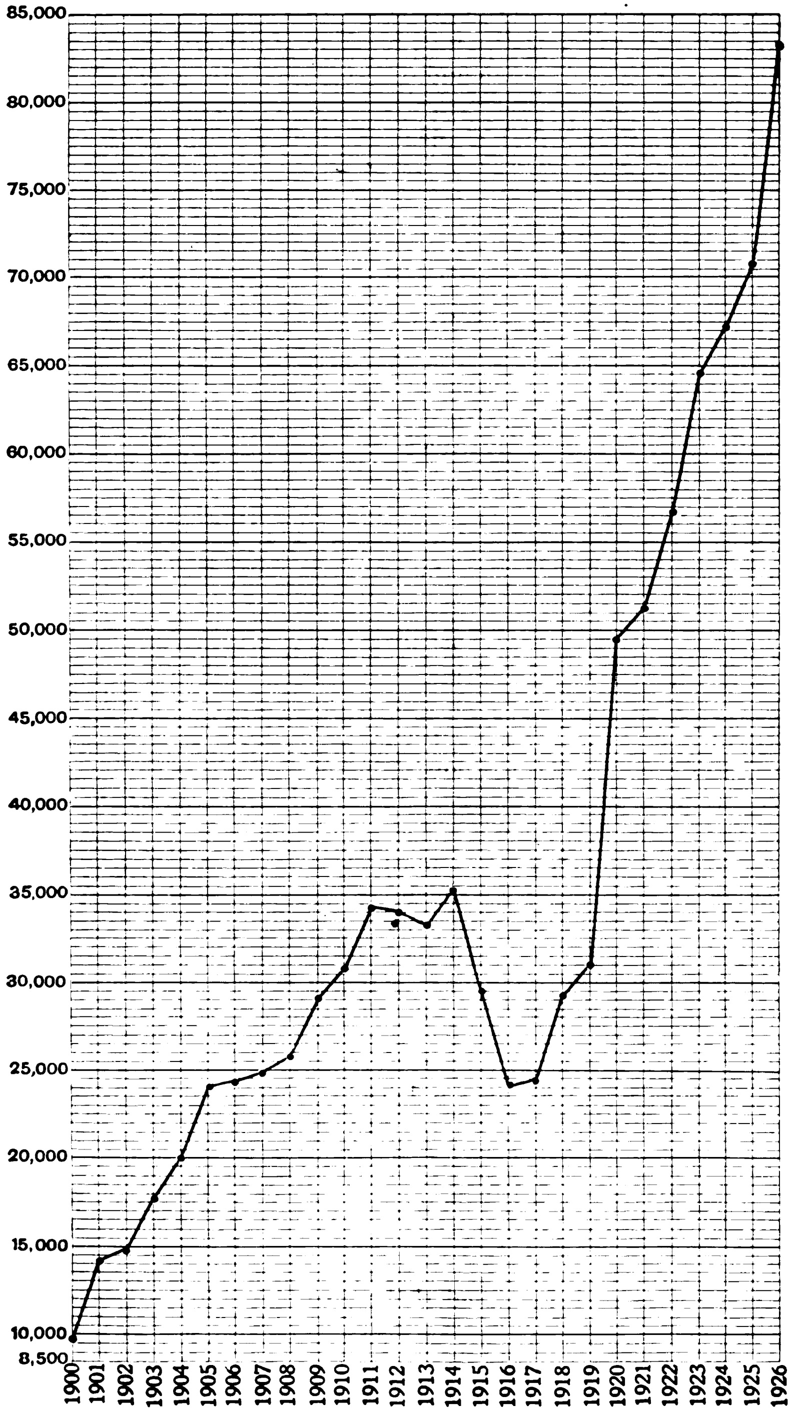
Advanced Stage.—Candidates must pass in the following four subjects in the Advanced Stage in three consecutive years: Economic Theory, Commerce (or Theory and Practice of Commerce), Book-keeping and any one of the remaining subjects (other than Shorthand, Typewriting, Précis-Writing, and Commercial Correspondence and Business Knowledge) in which an Examination in the Advanced Stage is held.

Intermediate Stage.—Candidates must pass in the following four subjects either in the Advanced or Intermediate Stage in three consecutive years: Commerce (or Theory and Practice of Commerce), Arithmetic, Book-keeping and any one of the other subjects in which an Examination in the Intermediate Stage is held. (For the purpose of this Certificate Shorthand and Typewriting will be considered as one subject).

It is not yet known how many applications there will be for these group prizes in the current year, but it is hoped to publish the names of the prize winners very shortly.

The thanks of the Council are once more accorded to the Court of the Clothworkers' Company, who have generously renewed their grant of £40 towards providing medals in all the subjects of examination where the work of candidates attains a sufficiently high standard. There is no doubt that there is very keen competition for these medals, and that they have done much to maintain or raise the level of excellence in the papers worked.

DIAGRAM SHOWING NUMBERS OF PAPERS WORKED IN THE EXAMINATIONS, 1900-1926.



DETAILS ON THE 1926 EXAMINATIONS.

Subjects.	Stage III.—Advanced.				Stage II.—Intermediate.				Stage I.—Elementary.			Total number of Papers worked in all Stages.	
	Papers worked.	1st-class Certificates.	2nd-class Certificates.	Not passed.	Papers worked.	1st-class Certificates.	2nd-class Certificates.	Not passed.	Papers worked.	Passed.	Not passed.	1926	1925
Arithmetic	309	30	96	183	2,712	635	1,109	968	7,752	5,617	2,135	10,773	7,728
English	463	31	235	197	2,167	163	1,065	939	4,559	2,750	1,809	7,189	5,973
Book-keeping	3,577	410	1,581	1,586	8,601	1,195	4,901	2,505	11,229	6,737	4,492	23,407	20,928
Economic Geography	70	11	36	23	414	52	236	126	811	576	235	1,295	626
Shorthand	1,417	136	365	916	7,475	1,547	2,161	3,767	8,199	4,879	3,320	17,091	14,691
Typewriting	756	160	442	154	3,020	993	1,556	471	4,481	3,529	952	8,257	7,174
Economic and Social History ..	19	7	10	2	52	5	40	7	88	58	30	159	83
Economic Theory	196	20	137	39	359	32	256	71	—	—	—	555	453
Précis-writing	37	5	21	11	113	18	55	40	—	—	—	150	130
Commercial Correspondence and Business Knowledge ..	111	9	38	64	1,111	84	479	548	2,687	1,732	955	3,909	3,968
Commercial Law	229	64	125	40	348	181	108	59	—	—	—	577	489
Company Law	90	20	62	8	228	123	81	24	—	—	—	318	308
Accounting	555	59	253	243	—	—	—	—	—	—	—	555	570
Banking	25	2	13	10	—	—	—	—	—	—	—	25	26
Costing	73	5	42	26	—	—	—	—	—	—	—	73	100
Foreign Exchange	19	8	10	1	9	4	4	1	—	—	—	28	38
Commerce	218	28	127	63	749	44	439	266	750	519	231	1,717	1,223
Railway Law and Practice	44	7	25	12	—	—	—	—	—	—	—	44	49
Railway Economics	17	5	8	4	—	—	—	—	—	—	—	17	25
Shipping Law and Practice ..	38	6	22	10	—	—	—	—	—	—	—	38	39
Stock Exchange Law & Practice	17	4	10	3	19	4	10	5	—	—	—	36	33
Insurance Law and Practice	10	2	6	2	—	—	—	—	—	—	—	10	9
Advertising and Salesmanship	40	8	24	8	—	—	—	—	—	—	—	40	35
French	445	95	248	102	2,061	458	1,113	490	3,241	2,368	873	5,747	4,786
German	50	8	24	18	161	32	81	48	199	118	81	410	429
Italian	14	5	8	1	28	10	16	2	46	41	5	88	93
Spanish	109	11	78	20	225	20	177	28	373	332	41	707	590
Russian	2	1	1	—	6	1	4	1	10	8	2	18	18
Danish and Norwegian ..	—	—	—	—	—	—	—	—	—	—	—	—	5
Portuguese	4	1	3	—	4	1	3		—	—	—	8	13
Swedish	—	—	—		5	—	3	2	—	—	—	5	6
Totals, 1926	8,954	1,158	4,050	3,740	20,867	5,602	13,807	10,308	44,125	29,264	15,161	83,240	-
" 1925	8,250	1,038	3,740	3,181	25,427	3,452	14,402	7,513	30,952	24,806	12,146		70,038

The Examination Syllabus for 1927* has been issued. In it will be found the fullest possible information about the examinations, a syllabus of each stage of each subject, and list of centres. The papers set in 1926 have been reprinted in six pamphlets. Each pamphlet contains, in addition to the papers of each stage, the syllabuses of the subjects in the pamphlet and the Examiners' reports on the papers worked.

The regulations for the Oral Examinations in Modern Languages are also given at full length in the syllabus.

* The price of the Syllabus for 1927 is 4*d*., post free. Copies can be obtained on application to the Examinations Officer, Royal Society of Arts, Adelphi, London, W.C.(2). The price of the pamphlets containing the 1926 papers is 4*d*. each, post free. Particulars of these may be obtained as above.

THE PEARL FISHERIES OF COLOMBIA.

The richest of the Colombian pearl beds are on the north coast of the Goajira Peninsula, from Cabo de la Vela to Castilletes. Some pearls are taken near the Bay of Cartagena. Native divers bring up the shells, no equipment being used. Each boat pays the Federal Government 350 pesos per month license, and the rulings require that half of the boats operating must be of Colombian ownership, and that no company or individual may employ more than eight boats. Most of the pearls are marketed in Paris.

According to a recent report by the United States Commercial Attaché at Bogota, the Colombian Government is proposing itself to develop the industry on the Pacific coast, where pearl banks are known to exist off the island of Gorgona, in the region of Guapi, and mother-of-pearl off the Bay of Cupica.

At present 25 per cent. of the returns from the pearl fishing go to the Federal Treasury, 25 per cent. to the personnel of the boat, and 50 per cent. to the owner. This arrangement was established by a commission of 14 appointed by executive decree for the inspection and exploration of the Pacific pearl beds. The Government plan for future operation is to divide pearl fishing into three zones, fixing alternating seasons for fishing, thus giving time for replenishing the beds.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, OCTOBER 18..East India Association, at Caxton Hall, Westminster, S.W.1. 3.30 p.m. Sir Richard M. Dane, "Opium in China and India."

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Prince D. Sovatopolk Mirsky, "The Great Russian Poets." (Lecture II.)

At King's College, Strand, W.C.2. 5.30 p.m. Le Père Delehaye, "L'histoire du culte des Saints dans l'Antiquité." (Lecture I.)

5.30 p.m. Major W. E. a. B. Whittaker, "The Battles of the Somme, 1916." (Lecture II.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5 p.m. Mr. William Cash, "Published Balance Sheets."

At University College, Gower Street, W.C.1. 5 p.m. Mr. R. J. Lythgoe, "The Special Senses." (Lecture V.)

5.30 p.m. Prof. E. G. Gardner, "The *Little Flowers* of St. Francis."

TUESDAY, OCTOBER 19..Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, F.R.C.S., Anatomy—Lecture 5—"The Upper Limb: its connexion with the Trunk; Bones and Muscles studied in association with the Surface Forms in Action and Repose."

Chadwick Public Lecture, at the Royal Society of Medicine, 1, Wimpole Street, W. 5 p.m. Prof. Dr. Abel, "The Development and Present State of Public Health in Germany." (Lecture I.)

Master Glass Painters, British Society of, at 6, Queen Square, W.C.1. 5.30 p.m. The Rev. F. Harrison "The Stained Glass of York Minster."

Roman Studies, Society for the promotion of, at the Society of Antiquaries, Burlington House, W. 4.30 p.m. Mrs. S. A. Strong, "Recent discoveries in Rome and Italy: sculpture and the reorganisation of the Museums."

Transport, Institute of, at the Institution of Electrical Engineers, Victoria Embankment, W.C.2. 5.30 p.m. Capt. F. L. Barnard, "Commercial Flying."

Zoological Society of London, Regent's Park, N.W.8. 5.30 p.m. Ordinary Meeting for Scientific Business.

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Sir Bernard Pares, K.B.E., "Contemporary Russia." (Lecture II.)
At King's College, Strand, W.C.2. 5.30 p.m. Professor O. Jespersen, "Sex and Gender in English Historical Grammar." (Lecture II.)
5.30 p.m. The Rev. Percy Dearmer, "Spanish Art." (Lecture II.)
5.30 p.m. Prof. Dr. C. Lloyd Morgan, "The Place of Mind in an Organic Theory of Nature." (Lecture I.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5.15 p.m. "Accounting in Public Offices."
At the School of Oriental Studies, London Institution, Finsbury Circus, E.C. 5 p.m. Dr. L. D. Barnett, "An Introduction to Indian Philosophy." (Lecture I.)

WEDNESDAY, OCTOBER 20..Chadwick Public Lecture, at the Royal Society of Medicine, 1, Wimpole Street, W. 8 p.m. Prof. Dr. Abel, "The Development and Present State of Public Health in Germany." (Lecture II.)

Constructive Birth Control, Society for, at Essex Hall, Essex Street, Strand, W.C. 8 p.m. Dr. C. W. Saleeby, "The Expectant Mother."

Egypt Exploration Society, at the Royal Society, Burlington House, Piccadilly, W.1. 8.30 p.m. Dr. H. R. Hall, "Cities of Egypt—Thebes."

University of London, at the Institution of Electrical Engineers, Victoria Embankment, W.C.2. 5.30 p.m. Professor Dr. J. A. Fleming, "The Interaction of Pure Scientific Research and Electrical Engineering Practice." (Lecture I.)
At King's College, Strand, W.C.2. 5.30 p.m. Le Père Delehaye, "L'histoire du culte des Saints dans l'Antiquité." (Lecture II.)
5.30 p.m. Professor O. Jespersen, "Sex and Gender in English Historical Grammar." (Lecture III.)
5.30 p.m. Dr. E. F. Jacob, "The Beginnings of Chivalry."
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 6 p.m. "Office Machinery." (Lecture III.)
3 p.m. Signor Camillo Pellizzi, "Dante e la Commedia nel giudizio dei contemporanei." (Lecture I.)
At University College, Gower Street, W.C.1 5 p.m. Mr. R. J. Lythgoe, "The Special Senses." (Lecture VI.)
5.30 p.m. Mr. J. H. Helweg, "Hans Christian Andersen." (Lecture I.)

THURSDAY, OCTOBER 21..Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 6.30 p.m. Mr. W. R. D. Jones, "Notes on Magnesium and some of its Alloys."
Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. H. V. A. Briscoe, P. L. Robinson and H. C. Smith, "The Density of Boron Trichloride, and the Suspected Variation in the Atomic Weight of Boron." (2) Mr. W. H. J. Vernon, "The formation of Protective Oxide Films on Copper and Brass by Exposure to Air at various Temperatures." (3) Mr. W. H. Gray, "The Action of Antimony Trichloride upon some Diazotised Diamines." (4) Messrs. E. H. Farmer and J. Ross, "The Formation and Stability of Associated Alicyclic Systems. Part III.—The Change from 'Meta-' to 'para-' Bridged Rings."

Child Study Society, at 90, Buckingham Palace Road, S.W. 6 p.m. Miss Margaret Morris, "Dancing as Physical Culture."
Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C.

Tropical Medicine and Hygiene, Royal Society of, 11 Chandos Street, Cavendish Square, W. 7.45 p.m. Demonstration. 8.15 p.m. Professor N. H. Fairley, "Studies in the Chemotherapy and Immunity Reactions of Schistosomiasis." (Opening Meeting).

University of London, at Bedford College for Women Regent's Park, N.W.1. 5.15 p.m. Mr. Hartley Withers, "Currency Problems in Europe since the War."
At the Institute of Historical Research, Malet Street W.C.1. 5.30 p.m. Baron A. F. Meyendorff, "Russian Thought on Problems of Ethics." (Lecture II.)
At King's College, Strand, W.C.2. 5 p.m. Dr. C. Da Fano. "Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System." (Lecture III.)
5.30 p.m. Dr. E. V. Appleton, "Wireless Telegraphy." (Lecture III.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5 p.m. Professor G. Salvemini, "Economic, Social and Political Life of the Italian Communes in the Thirteenth Century." (Lecture III.)
5 p.m. Prof. A. J. Toynbee, "Aspects of International History since the War." (Lecture I.)
At University College, Gower Street, W.C.1. 5.15 p.m. Dr. T. Pinches, "Recent Discoveries in Babylonia." (Lecture III.)
5.15 p.m. Prof. J. E. G. de Montmorency, "Legislative Tendencies in the English Speaking World." (Lecture I.)
5.30 p.m. Dr. Walter Seton, "The Chief Documents upon which our Knowledge of St. Francis is Based."

FRIDAY, OCTOBER 22..Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, F.R.C.S., Anatomy—Lecture 6—"The Upper Limb, its connexion with the Trunk; Bones and Muscles studied in association with the Surface Forms in Action and Repose."

Metals, Institute of, at the University, St. George's Square, Sheffield. Prof. H. C. H. Carpenter, F.R.S., Sorby Lecture. (Conjoint Meeting with other Societies interested.)

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m.

Transport, Institute of, at the Midland Hotel, Manchester, 6.30 p.m. Mr. R. W. Bradley, "The Work of the Railway Rates Tribunal."

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Dr. R. W. Seton-Watson, "Austria under Francis and Metternich." (Lecture I.)
At the Institution of Electrical Engineers, Victoria Embankment, W.C.2. 5.30 p.m. Professor Dr. J. A. Fleming, "The Interaction of Pure Scientific Research and Electrical Engineering Practice." (Lecture II.)
At King's College, Strand, W.C.2. 5.30 p.m. Professor A. Koszul, "Some Relations between Alsace and England in the Sixteenth Century."
5.30 p.m. Le Père Delehaye, "L'histoire du culte des Saints dans l'Antiquité." (Lecture III.)
5.30 p.m. Prof. Dr. R. S. Conway, "Livy and the Empire."
At the University College, Gower Street, W.C.1. 5 p.m. Mr. R. K. Cannan, "Biological Oxidation—Reduction." (Lecture III.)

SATURDAY, OCTOBER 23..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. V. Gordon Childe, "The Dawn of Civilisation in Europe."

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FRIDAY, OCTOBER 22nd, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, OCTOBER 27th, at 8 p.m. (Trueman Wood Lecture.) DR. ROBIN JOHN TILLYARD, M.A., D.Sc., F.R.S., F.L.S., Chief of the Biological Department of the Cawthron Institute of Scientific Research, Nelson, New Zealand, "The Progress of Economic Entomology." SIR THOMAS HENRY HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., will preside.

The Lecture is being delivered before the date of the formal opening meeting on November 10th, owing to the fact that the lecturer has to return to New Zealand before that date.

Tea and coffee will be served in the Library after the meeting.

COUNCIL.

A meeting of the Council was held on Monday, October 11th. Present :—Mr. Alan A. Campbell Swinton, F.R.S., in the Chair; Sir Charles H. Armstrong; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Frank Baines, C.V.O., C.B.E.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.; Sir William Henry Davison, K.B.E., D.L., M.P.; Sir Archibald Denny, Bt., LL.D.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Rear-Admiral James de Courcy Hamilton, M.V.O; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir John O. Miller, K.C.S.I.; Sir George Sutton, Bt.; Mr. Carmichael Thomas; Professor J. M. Thomson, F.R.S.; Dr. J. Augustus Voelcker, M.A., Ph.D.; Sir Frank Warner, K.B.E.; and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. William Perry, B.A. (Assistant-Secretary).

The arrangements for the forthcoming session, so far as they are at present completed, were approved; and a number of papers which had been submitted were considered.

Mr. Charles R. Darling was appointed to deliver the Dr. Mann Juvenile Lectures in January, 1927, his subject being "The Story of a Wireless Valve." The lectures will be fully illustrated with experiments.

The Reports of the Judges on the Competition of Industrial Designs were laid on the table; and it was reported that the various sectional committees were now making arrangements for the Competition of 1927.

A vote of thanks was accorded to Mr. J. A. Milne, C.B.E., Chairman of the Book Production Committee, for his kindness in designing, executing and providing the certificates awarded to candidates whose work was either "Highly Commended" or "Commended" at the Competition of 1926.

It was reported that the Committee were making arrangements for calling a conference upon the question of the Preservation of Ancient Cottages, the date of which it is hoped to announce shortly.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ORNAMENT IN BRITAIN.

By Charles Reed Peers, C.B.E., M.A., F.B.A.,

Director of the Society of Antiquaries and Chief Inspector of Ancient Monuments, H.M. Office of Works.

Lecture I.—*Delivered April 19th*, 1926.

Man, as distinct from other animals, has been defined as a fire-maker and tool-maker. It may be claimed for him with equal reason that he is further distinguished as being a maker of ornament. Ornament, to hazard a definition, is something decorative designed by man, whether for his own pleasure or to convey a definite idea. A direct representation of some object is not essentially ornament. Ornament must imply an adaptation or arrangement, influenced by its surroundings, by the size and shape of the substance on which it is placed. It is intended, we may say, to increase the attractions of the thing ornamented, it being assumed that beauty, by whatever standard it be judged, is the source of attraction. On this we may build and say that attraction—an attractive object—evokes attention, and that it is a function of ornament—one may even say a merit, and therefore a test of good ornament—to emphasize parts of an object or structure, to create a balance of parts and to give proportion.

A natural object, or a manufactured substance, may become ornament by application to another object or substance, but in the ordinary acceptance

of the word, ornament is produced by the application either of line or relief, with or without colour, to the surface of the thing which is to be ornamented. At what stage of his career man first set his hand to the making of ornament can only be conjectured, but it must have been at a very early stage. Perhaps, if we could see them, we should hardly be agreed on the ornamental nature of his first attempts.

There was indeed art, and of no mean order, in palaeolithic times, but its aim was direct representation, and we have no grounds for assuming that convention or arrangement had any place in the mind of the skin-clad artist who at Altamira or Les Eyzies drew on the rocky walls of his cave dwelling, by such artificial light as he could contrive, those simple but keenly-observed animals with which we have of late years become familiar. Moreover Britain has produced nothing, or practically nothing, of this kind, and I must with reluctance pass on to matters more within the limits of these lectures.

FIG 1.—Neolithic Pottery.

Although the trend of modern research has been to abolish the hiatus formerly assumed to exist between the old Stone Age and the new Stone Age, it cannot be claimed for neolithic man that he carries on the artistic tradition of his predecessors in culture. His mastery over materials is shown in the perfect lines and contours of his implements, but of representational drawing he seems to have no idea. The instinct of decoration, however, he shares with other primitive people, and he must take his place as the first maker of ornament, in the true sense of the word, in Britain. (Fig. 1).

And here, at the beginning of a long story, it will be well to have no illusions on certain definite points. Whatever we may think of ourselves now, it must be remembered that till comparatively recent times, Britain was at the world's

end. When we were taking our first steps, we were entering on a road which other nations had trodden thousands, even many thousands, of years before, and when we were producing our proto-archaic simplicities, other craftsmen were creating masterpieces, which in spite of all that has happened since are masterpieces still. So that, when we follow the course of what was produced within our shores, we must bear in mind the possibility, ever increasing as time goes on, of external influence which will interrupt any ordered sequence, and give a new direction to a growing and developing tradition.

You will see that this fact naturally leads to the consideration of a matter on which much can be, or has been, said, namely, the meaning of ornament as distinct from its decorative function. Whether in this or in any other department of man's activities, nothing comes by chance. Immediate causes may be obscure and even trivial, but that they exist and form part of a scheme we cannot doubt. Where the thing made conveys a definite idea, the proximate causes of its making, at any rate, are apparent. An implement or weapon, a piece of furniture, a sculptured figure, a representational drawing, proclaim the intention of the craftsman producing them. But with ornament, which, as we have seen, involves arrangement or convention, we are at one remove from actuality. And this is true not only of the spectator, but of the producer. So that we must expect, and shall see reason to believe, that in ornament convention is apt to be followed mechanically, and that forms which once had a meaning may be and are perpetuated without any knowledge of, or indeed, concern for, that meaning. Equally a form which has become meaningless may, in a speculative generation, have a meaning read into it, and be modified accordingly. For these reasons ornamental forms, and not least in our own country, are likely to be peculiarly subject to external influences, and to fashions which may be as casual in their origin as the fashions of to-day.

We have seen that man's creative instinct seems at first concerned with representation, and it would not be illogical to suppose that, as long as this idea remained, ornamental convention would not develop. But in coming to the consideration of the first essays in ornament which I propose to bring before you, an imitative element clearly shows itself. In the latter part of the neolithic period we find in Europe, and notably in Spain, a series of ornamental earthenware vessels produced by a people who from their production of this pottery have been called the beaker folk. It appears that their arrival in Britain coincides with, though is not definitely responsible for, the beginning of the use of bronze in this country. The earthenware vessels which they made, and which we find in their graves, have received the name of beakers, and are wide-mouthed and cylindrical, often of excellent workmanship. Certain definite forms can be recognised and a sequence in date deduced. Of the early forms, that known as the gourd-beaker has a low ovoid body and a tall neck, and while the body is plain the neck is covered with a simple linear pattern. The derivation of this vessel from a gourd, to which a wickerwork

neck has been fitted, may be allowed, and in this case the existence of ornament on the neck, and its character, and on the other hand its absence from the body, seem to be due to direct copying, the pottery vessel being intended as a substitute for the other. When, however, we try to analyse the decoration of the beakers, we find a variety of incised or impressed markings arranged in patterns from which no consistent theory of development can be deduced. The ornament, we are tempted to say, is ornament for its own sake. It may be drawn with a point, impressed with the finger or finger-nail or any blunt object, or made with some form of stamp. Anything like a sequence, showing a development from the simplest forms to something more elaborate, it is not possible to deduce, and some of the most primitive patterns occur on vessels which typologically must be considered late in the series. (Fig. 2).

FIG. 2.—Bronze Age Pottery.

These beakers, after a common custom in primitive civilisation, seem to have been intended to contain provisions for use in another world. As time goes on, the change in fashion brings in other forms of vessel, in the first place one which from its unsuitability to contain liquor has been called a food vessel; then, as the form of burial changed from inhumation to cremation, urns to contain the burnt bones appear, and last in the series are certain small vessels with openings in the sides, which seem suitable for little except to contain burning charcoal or the like, and have received the name of incense cups. (Fig. 3). It must be made clear, by the way, that these forms are not mutually exclusive, but that their use overlaps.

The evidence from finds is that the earlier food-vessels are contemporary with the later beakers, that urns and incense cups go with the later food-vessels, and that the last in point of date are the later types of urns and incense cups.

It further appears that the food-vessels are a local development, and occur only in the British Isles. Though of less skilful fabric than the beakers, their ornament is at least of equal merit with that of the older forms, and, indeed, has a delicacy which is not found on the beakers. We shall see in the course of these lectures that this is a phenomenon which is more than once repeated, and appears to be due to the geographical rather than the racial conditions obtaining in Britain. As I have said, we were at the end of the world, and the influences, migratory or invading, which reached our shores, being thrown back on themselves, will be found to lose certain elements and develop others, and the general direction is towards a delicacy of detail but a loss of vigour. In these early times an inherited sequence of ideas is not to be thought of;

FIG. 3.—Incense Cup.

that can only be conveyed by a nation with a developed race-instinct, and the race was as yet only in the making. So that we must be careful not to regard temporary developments as definite progress, and for the time at least must recognise characteristics in tendencies only and not in achievements.

The line of development of these earliest essays in ornament is so simple that we are inclined to pass them by as merely obvious. From a dot made with any blunt instrument, a stick or a finger, we come to a scratch, or line, straight or intended to be so. Then combinations of straight lines into patterns, the fore-runners of figures. (Fig. 4). An advance to curved lines and spirals, which need more power of directing the instrument used, will be the next step. (Fig. 5). And through all we may see signs of the effect of his work on the artist himself; his recognition of the value of a grouping or distribution of the units, and perhaps, though here we tremble on the

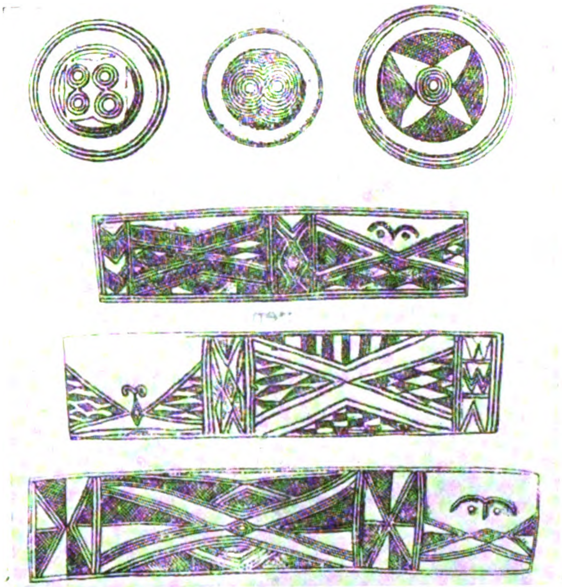

FIG. 4.—Ornament on Chalk Drum, Folkton, Yorks.

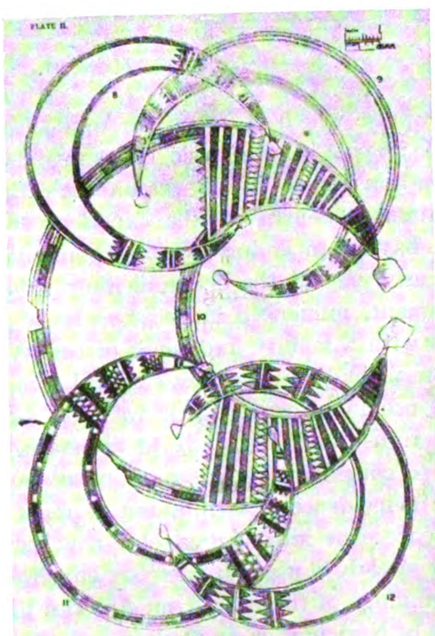

FIG. 5.—Gold Lunulae.

treacherous brink of art-criticism, the intention to convey an idea. Let us be contented here rather to record than to attempt interpretation.

So far we may say that the simple elements of the primitive ornament we have been considering demand no elaborate theory of origin; no long history of development is needed to explain them, and no external influence seems necessary for their growth. But in proportion as civilisation develops its impulses are likely to have a wider range, and it is only a question of time before those who dwell on its outskirts must consciously or unconsciously take them into account. Now European culture, if the phrase may be allowed, had its beginnings outside Europe, a little to the East of the Mediterranean. Its centre moving westwards to the eastern half of the Mediterranean there arose that orderly, reasonable and accomplished expression

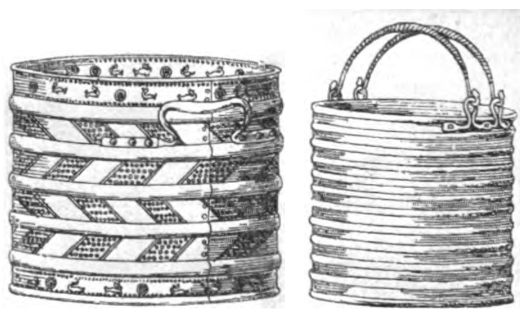

FIG. 6.—Buckets from Hallstatt.

of man's creative impulse which is for us par excellence the classic art, and that which is outside its pale is non-classic, or, as men used to say, barbarian. The barbarian, to do him justice, is only man at an earlier stage in his education, and in a position to benefit by the experience of his more advanced neighbours without having to endure so long a pupilage as they. And so we may see in the early part of the first millenium before our era, the origin of a school of ornament, influenced indeed by classic forms, but developed on quite other lines with a facility and sense of beauty in face of which the primitive linear patterns had no chance of survival.

As the primitive ornament with which we have been dealing is for us associated with the transition from stone to bronze in culture, so this next development seems to coincide with the adoption of iron-working in Europe. As a landmark the coincidence is useful, but it must be remembered that it is only a coincidence: the introduction of a new metal neither causes the supersession of those already in use, nor exercises any direct influence on design. For Europe the beginnings of the early Iron Age can be located in what was the Roman province of Noricum, or, in modern parlance, Styria and Carinthia, where iron ore existed in abundance. In this region lie the cemeteries of Hall-

statt, which have given a name to the first cultural phase of the early Iron Age, and are the burial places of a folk whose racial origin is yet in dispute, but who have some claim to be considered as a branch of the Kelts who under various names played so prominent a part in early European history.

Now the geometric art of the Bronze Age is considered to be continued in Greece and Italy by the cultures known respectively as the Dipylon and Villanova schools. Characteristic of these are such decorative features as the maeander, the swastika, the step pattern, triangles and rectangles, generally arranged in horizontal bands; in fact, a more articulate phase of the linear ornament we have already been considering on the Bronze Age pottery and metal work of Britain. At Hallstatt precisely the same forms occur (Fig. 6), and probably at much the same date as in Greece and Italy. The products of these workshops were carried by various trade routes all over Europe, and have been found in Britain. Till very recent days no evidences of more than casual importation into the country have been available, but the excavations of the last few years have provided adequate grounds for the opinion that pottery

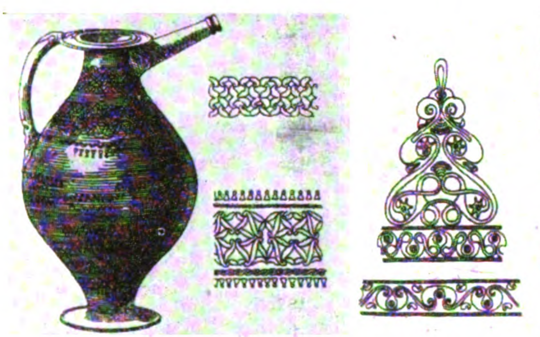

FIG. 7.—Detail of ornament, Waldalgesheim.

of the later Hallstatt period, that is, of the 4th and 5th centuries B.C., was actually made in Britain, implying an immigration of its makers.

This period, from the lack of objects available, is, however, one of the most obscure in our history. It has yet to be proved that any metal object, that is to say, brooches, jugs, buckets and the like, which are undoubtedly of the Hallstatt period and have occurred from time to time in Britain, were more than casual introductions by traders. They may witness to relations with Phrygians, Phœnicians and the Mediterranean peoples generally, but that they served as models to native British craftsmen or affected their designs cannot be affirmed.

The second part of the early Iron Age, generally called the La Téne period, and assumed to begin in the fifth century B.C., is of far more importance in the story of British art. Like the Hallstatt culture, the classic influence is apparent in its design, but to much more purpose, and direct borrowing of

motives from Greek art is obvious. The peoples included in its area, centreing on the middle Rhine and spreading right across Europe, comprise the Kelts and Gauls of the Roman writers, and were a tall fair-haired people of North German, Teutonic or Scandinavian provenance, of various racial types, but connected by a common language. One of these tribes, the Belgae, who were of Teutonic origin, established themselves in the middle of the 3rd century B.C. in Gallia Belgica, *i.e.*, the lands between Rhine, Marne and Seine, and some 150 years or more later seem to have passed over into Britain, bringing with them that art which was destined to so remarkable a development, and which, under the name of Late-Celtic, is familiar to all students of British antiquities.

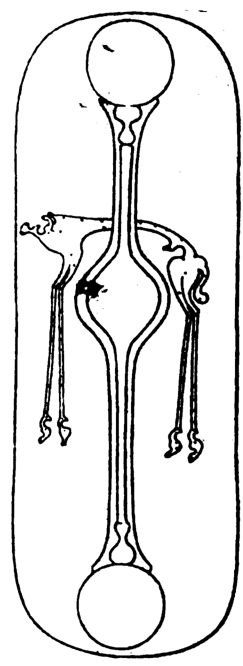

FIG. 8.—Shield from Witham.

Its germ may be seen in the finds made in the 5th century cemetery at Waldalgesheim, near Coblentz. (Fig. 7). Here, together with vessels of actual Greek manufacture, were found others of "barbarian" character, showing in their decoration certain modifications of the Greek palmette, which, in their development, lead to the trumpet spirals which are the characteristic note of Late-Celtic art in Britain.

Even in this initial stage can be seen the feeling for line which led to such remarkable results in Britain, and to the establishment there of a school of ornament, which, though submerged and even driven out by the Roman

conquest and occupation, survived beyond the limits of the Roman Empire, and when that Empire grew feeble and withdrew before the gathering strength of the northern nations, returned again and nearly 1,000 years after its first introduction played its part in that remarkable renaissance of the 7th and 8th centuries, which followed on the re-introduction of Christianity into Britain.

In so long a period as that during which the Late-Celtic style continued in use in Britain, the question of dating becomes of much interest. The latest survivals fall within a period outside that which we are now considering, and I must defer a full examination of them till the second lecture of this series. With regard to the earliest forms, we may clear the ground to some degree

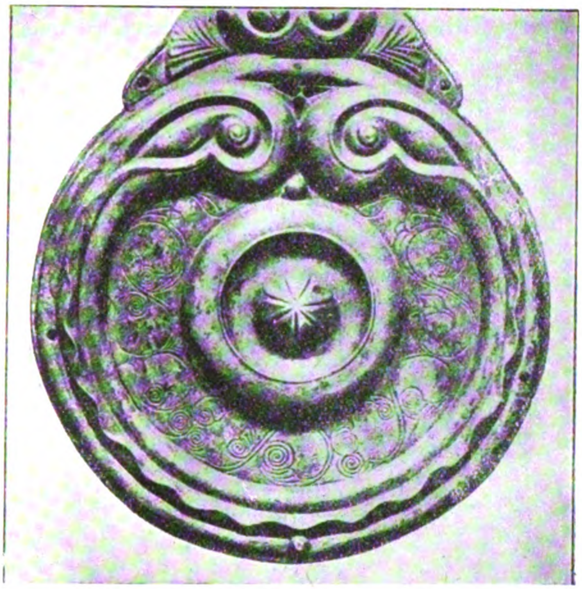

FIG. 9.—Detail of Shield from Witham.

by a consideration of the bronze shield found in the River Witham, in Lincolnshire. This includes among its ornament discs of red coral, a material in use on the Continent in the latter part of the Hallstatt period and early in that of La Téne. M. Salomon Reinach having drawn up a list of examples believes that coral went out of use in Europe about 250 B.C., its place being taken by red enamels. This date must be considered too early for Britain, a fact, which is, as we have already seen, only natural, and the Witham shield may belong to the 2nd century B.C., though instances of coral of possible 1st century date might be adduced from Britain. The form of its ornament is to be noted; the oval boss in the middle, and the longitudinal rib resembling that on the shield shown in the well-known sculpture of the Dying Gaul,

carved about 230 B.C. to commemorate victory over the Gauls in Asia Minor. But the circular bosses at either end of the rib seem a later development, possibly originating in Britain. What from the point of view of ornament is particularly notable is the figure, or rather the traces of the figure, of a boar across the middle of the shield. (Fig. 8). Convention is here carried to a great distance, but it is skilled and practised convention—not, as on the Aylesford bucket, a somewhat childish travesty of a classical original. This is a Late-Celtic boar and nothing else, with a fine feeling for line, and placed on the shield in the only possible way, as a central device which yet does not clash with the central boss. The barbarian who made this was master of a style able to express itself, and no longer dependent for its ideas on classic art. If you will examine the small details of one of the terminal bosses, you will see the certainty and beauty of the modelling, and the unrivalled mastery of flowing

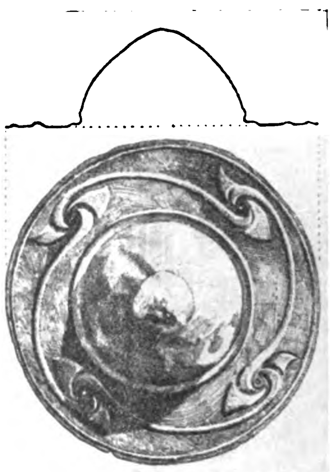

FIG. 10.—Shield Box from Polden Hills.

line. (Fig. 9). Note also the running pattern round the central boss, with its adaptation of classic foliage, perfectly in tone with the spirals native to the style. Here is something borrowed and yet assimilated; something which, within the limits of its conception, is perfectly successful.

To take another example, a shield found in the Thames at Battersea. Here is something not relatively, but absolutely fine. The design, in which the terminal circles have grown in importance, and the central feature is a perfectly proportioned and dominating circle, is clearly a development from that of the Witham shield. Moreover, the red ornament is no longer coral, but red enamel, and applied as enamel should be, that is to say, fused in position. The point is of importance, as there is an intermediate step. On a certain number of metal objects of this date there is decoration of red enamel which

has been cut out from a larger block and fitted into its place, as the coral which it succeeds would have been. Here we have the fully developed process, witnessing to the growth in technical skill of the craftsman; he has become master of the process of champlevé enamel. An interesting commentary on this art, which we may with confidence claim to have been developed in Britain, is found in a passage in the writings of Philostratus, a Greek sophist at the Imperial Court of Rome in the time of the Emperor Severus, that is, early in the 3rd century A.D. It runs thus:—

> "They say that the barbarians who live in Ocean pour colours on heated bronze, and that they adhere, become hard as stone, and preserve the designs that are made in them."

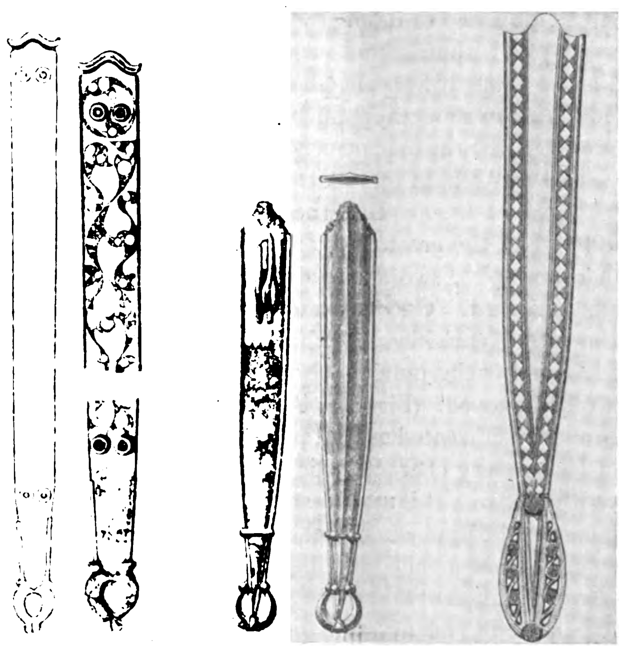

FIG. 11.—Sword Sheaths from Bugthorpe, Yorks., and Wandsworth.

Allowing for the fact that this is the sort of remark a sophist would make, for there was at the time nothing new in the champlevé process, the testimony to the reputation of our native enamellers (for the barbarians who live in Ocean, that is, the great river which surrounded the world as the ancients conceived of it, are almost certainly our British forefathers) is well worth recording.

To compare the details of this shield with the other, you may see further obvious signs of development. There is more insistence on, and, one may add, more mastery of balance and proportion: the raised portions are more sharp

and slender: your attention is directed to the line and not distracted by having to examine enrichments of the surfaces. The enamel circles are of one and the same design, a swastika on a red field, and add emphasis without dominating the whole. The date must be about the year 1, the time when the native chieftains, whose successors were to succumb to the Roman arms, were wealthy and prosperous—the time of Shakespeare's Cymbeline, and Lear, and if you will forgive the bathos, of Old King Cole. These people imported, as we know from their tomb-furniture, the fine works of Greek and Roman metal-workers, and we may be sure with full appreciation of their merits. Such shields as these, moreover, would surely be arms of parade, for splendour and not for use: such masterpieces would hardly be exposed to the risks of battle.

To carry on the sequence of dates, red enamel occurs in a hoard of bronze objects, bridle bits and trappings and such-like, found on the top of the Polden Hills near Edington, Somerset. The shield boss found with them is circular, and seems in its shape to show the influence of the Roman round buckler. (Fig. 10). It may date from early in the 2nd century A.D., and, though not to compare in splendour with the Witham and Battersea examples, shows the same easy mastery and subtlety of line. But the native is no longer the undisputed master of his land, and the great days are past.

To take other examples, sword and dagger sheaths may help to show the character of this ornament. One from the Thames at Wandsworth is admirable in line, and the spirals enriching the chape are easy and entirely decorative. Note also the hatched background to the border of lozenges on the sheath and the sense of colour conveyed. (Fig. 11). A sword sheath from Bugthorpe, fouud with two discs of enamel treated as imitation coral, *i.e.*, applied and not fused on to the metal, has a very characteristic ornament in the hatching rather like some wickerwork pattern. It is more restless than those we have seen, but yet, from the character of the applied enamel, of relatively early date. To compare it with a specimen from a lake dwelling in Ireland (Co. Antrim), is useful. But it must be remembered that if fashions lingered in Britain, they were yet more apt to linger in Ireland, and there is no reason to place this example early in the series. It is careful and well balanced, but a witness of survival rather than development. A chariot axle-end, from the Thames, is full of fine line and elegance, and may well go with the fine weapons we have been examining.

The bit, equally fine, shows a further step in the history of enamels, having blue as well as red: this may well come from contact with the many coloured Roman enamels, and *pro tanto* must be held of later date.

THE PHILIPPINE EMBROIDERY INDUSTRY.

According to the official United States "Commerce Reports," the development of the Philippine embroidery industry as a commercial proposition has taken place during the last 10 years. The United States has been the most important, in fact, practically the only market for these exports from the islands, taking cotton embroideries, laces, and wearing apparel valued at over $4,000,000 in 1924, compared with only $34,000 in 1914. These imports consisted principally of articles of embroidery and included lingerie, children's garments and infants' wear, handkerchiefs, tablecloths, parasols, and boudoir apparel.

Most of the embroidery is prepared on direct order from the United States, and practically no stocks are kept in the islands. The central organisation, or so-called "factory," in Manila issues the patterned cloth to the individual workers or their agents, and, on the return and acceptance of the embroidered material, supervises its preparation for export. Materials, principally cotton, are purchased largely in the United States. Embroidery buyers in the States are generally required to make shipments of cloth to cover full yardage of the order, both as an assurance that there will be sufficient material to cover the contract, and as a guarantee of good faith on the part of the buyers. The work is done largely in remote places, by the poorest classes.

Some of the materials used are very fine, and the finished products are examples of excellent design and great skill in workmanship. In other cases, the cloth used is coarser, and the articles are of the sales-counter type. The average quality of the output has suffered during recent years by the desire of a number of firms for quantity rather than quality production.

THE JAPANESE CORAL INDUSTRY.

The coral industry of Taiwan (Formosa) is a new industry which has shown a remarkable development. It appears from a report by the United States Consul at Taihoku that coral was discovered in the sea of Keelung in June, 1924, and within six months Taiwan was recognised as among the foremost coral producing centres. The yield in the last six months of 1924 was valued at 810,000 yen, and the coral collected during 1925 amounted to 20,683 pounds, and was valued at more than 1,000,000 yen. (The par value of the yen is 2*s*. 0½*d*.)

The Taiwan coral is of a quality unsurpassed in the world's markets. Naturally there are various grades and colours, the red, deep red, and rare pale rose colours predominating. The bulk of the production has a high commercial value.

Although it is impossible to estimate the coral resources of the seas off Keelung, experienced coral fishermen state that the area is extensive and sufficient in deposits to maintain the present rate of yield for a period of at least 20 years.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, OCTOBER 25..Chadwick Public Lecture, at Southampton University College, p.m. Dr. H. T. Calvert, "The Activated Sludge Process of Sewage Treatment."

British Commercial Gas Association, Newcastle-on-Tyne. Fifteenth Annual Conference. Dr. C. W. Saleeby, "Sunlight and Health."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Discussion on "Does Heavy-current or Light-current Electrical Engineering afford the greater scope to Young Men with Electrical Engineering Ability?" (Opened by the President of the Institution).

At the University, Liverpool. 7 p.m. Mr. P. J. Robinson, Chairman's Address.

At Armstrong College, Newcastle-on-Tyne. p.m. Mr. J. Rosen, Chairman's Address.

Mechanical Engineers, Institution of, Storey's Gate, St. James Park, S.W. 7 p.m. Mr. E. L. Diamond, "An Investigation into the Cylinder Losses of Locomotive Engines."

Société Internationale de Philologie Sciences et Beaux-Arts, at 8 Taviton Street, W.C. 3.30 p.m. Dr. C. H. Betts, "The Forerunners of the Greeks."

University of London. At the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Prince D. Svyatopolk Mirsky, "The Great Russian Poets." (Lecture III.)
At King's College, Strand, W.C.2. 5.30 p.m. Major W. E. de B. Whittaker, "The Battles of the Somme, 1916." (Lecture III.)
5.30 p.m. The Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture I.)
5.30 p.m. Mr. C. J. Gadd, "Evil Spirits in Babylonian Religion."
8.30 p.m. M. André Maurois, "Benjamin Disraeli: The Earl of Beaconsfield."
At University College, Gower Street, W.C.1. 5 p.m. Mr. R. J. Lythgoe, "The Special Senses." (Lecture VII.)
5.30 p.m. Professor Dr. E. G. Gardner, "The Franciscan School at Oxford."

TUESDAY, OCTOBER 26..Aeronautical Engineers, Institution of, at 39, Victoria Street, S.W.1. 6.30 p.m.

Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, F.R.C.S., "Anatomy—The Upper Limb." (Lecture VII.)

British Commercial Gas Association, Newcastle-on-Tyne. Fifteenth Annual Conference.

Civil Engineers, Institution of, Great George Street, S.W.1. 6 p.m. Senatore G. Marconi, "Radio Communications." (James Forrest Lecture.)

Electrical Engineers, Institution of, at the College, Loughborough. 6.45 p.m. Mr. R. B. Matthews, "Electro-Farming."

Illuminating Engineering Society, at 15, Savoy Street, Strand, W.C.2. 6.30 p.m. Opening Meeting.

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture III.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5.15 p.m. "Accounting in Public Offices." (Lecture IV.)
At King's College, Strand, W.C.2. 5.30 p.m. The Rev. Percy Dearmer, "Spanish Art." (Lecture III.)
5.30 p.m. Professor Dr. C. Lloyd Morgan, "The Place of Mind in an Organic Theory of Nature." (Lecture II.)

WEDNESDAY, OCTOBER 27..British Commercial Gas Association, Newcastle-on-Tyne. Fifteenth Annual Conference.

Faraday Society, at Burlington House, W. (1) Mr. A. C. Vivian, "Beryllium." (2) Mr. F. I. G. Rawlins, "The Chemical Constants of the Halogen Hybrides." (3) Mr. J. Colvin, "The Decomposition of Nitrosotriacetonamine in Presence of Hydroxyl Ion. Part I.—The Region of Small Concentration of Alkali." (4) Miss Freda M. Hunter, "Latent Heat of Dilution of Sugar Cane Solutions." (5) Mr. J. J. Hedges, "The Adsorption of Water by Colloidal Fibres." (6) Mr. A. N. Campbell, "The Anodic Behaviour of Ferro-Manganese." (7) Mr. T. Carlton Sutton, "Abnormal Absorption of Gases by Steel." (8) Messrs. R. H. Humphry and R. S. Jane, "The Observation of Cataphoresis in Colourless Sols.—I.—Rubber in Benzene." (9) Mr. J. S. Dunn, "A Simple Kinetic Theory of Viscosity." (10) Messrs. A. C. Chatterji and N. R. Dhar, "Condition of Silver Chromate in Gelatin from Electric Conductivity and Diffusive Experiments."

University of London, at the Institution of Electrical Engineers, Victoria Embankment, W.C.2. 5.30 p.m. Professor Dr. J. A. Fleming, "The Interaction of Pure Scientific Research and Electrical Engineering Practice." (Lecture III.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 6 p.m. "Office Machinery." (Lecture IV.)
At King's College, Strand, W.C.2. 5.30 p.m. M. Ch. Petit-Dutaillis, "Recherches à Faire pour Mieux Comprendre les Grandes Figures Historiques."
5.30 p.m. Dr. F. S. Shears, "The Chivalry of France."
At the School of Oriental Studies, London Institution, Finsbury Circus, E.C.2. 5 p.m. Mr. Abdul Aziz, "The Poetry and Teaching of Sir Muhammad Iqbal."
At University College, Gower Street, W.C.1. 3 p.m. Signor Camillo Pellizzi, "Dante e la Commedia nel giudizo dei contemporanei." (Lecture II.)
5 p.m. Mr. R. J. Lythgoe, "The Special Senses." (Lecture VIII.)
5.30 p.m. Mr. J. H. Helweg, "Hans Christian Andersen." (Lecture II.)

THURSDAY, OCTOBER 28..Antiquaries, Society of, Burlington House, W. 8.30 p.m.
Metals, Institute of, at the Engineers Club, Waterloo Street, Birmingham. 7 p.m. Prof. Dr. D. Hanson, "Fatigue."
Chemical Society, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 8 p.m. Prof. S. P. L. Sörensen, "The Composition and the Characterisation of Proteins." (Hugo Muller Lecture.)

University of London, at Bedford College for Women, Regent's Park, N.W.1. 5.15 p.m. Professor Dr. C. W. Alvord, "The Significance of the New Interpretation of Georgian Politics."
At the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Baron A. F. Meyendorff, "Russian Thought on Problems of Ethics." (Lecture III.)
At King's College, Strand, W.C.2. 5 p.m. Dr. C. Da Fano, "Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System." (Lecture IV.)
5.30 p.m. Mr. J. E. Barnard, "The Application of Microscopical Methods to Medical Research."
5.30 p.m. Mr. Ifor L. Evans, "The Economic Organisation of the Danubian Lands: 1878-1914." (Lecture I.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5 p.m. Professor G. Salvemini, "Economic, Social and Political Life of the Italian Communes in the Thirteenth Century." (Lecture IV.)
5 p.m. Prof. A. J. Toynbee, "Aspects of International History since the War." (Lecture II.)
At University College, Gower Street, W.C.1. 4.15 p.m. Professor F. Y. Eccles, "Bossuet." (Lecture III.)
5.15 p.m. Prof. J. E. G. de Montmorency, "Legislative Tendencies in the English Speaking World. (Lecture II.)
5.30 p.m. Professor Dr. E. G. Gardner, "St. Francis in Rome."

FRIDAY, OCTOBER 29..Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, F.R.C.S., "Anatomy—Essential Features of the Face, Head and Neck." (Lecture VIII.)

Mechanical Engineers, Institution of, at Storey's Gate, S.W. 7 p.m. Mr. Robert Lowe, "Steel Castings in Mechanical Engineering."

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Dr R. W. Seton-Watson, "Austria under Francis and Metternich." (Lecture II.)
At the Institution of Electrical Engineers, Victoria Embankment, W.C.2. 5.30 p.m. Professor Dr. J. A. Fleming, "The Interaction of Pure Scientific Research and Electrical Engineering Practice." (Lecture IV.)
At King's College, Strand, W.C.2. 5.30 p.m. Mr. G. H. Cowling, "Shakespeare and the Elizabethan Stage."
At University College, Gower Street, W.C.1. 5 p.m. Mr. R. K. Cannan, "Biological Oxidation-Reduction." (Lecture IV.)
At Westfield College, Hampstead, N.W. 5.30 p.m. Dr. Ernest Barker, "Some Factors in the Formation of National Character." (Lecture I.)

SATURDAY, OCTOBER 30..Leplay House, Regional Survey Conference, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 10 a.m. to 7 p.m.

L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "Seed-time and Harvest in Ancient Egypt."

Metals, Institute of, at the Neville Hall, Newgate Road, Newcastle-on-Tyne. 6.15 p.m. Joint Meeting with the Institute of British Foundrymen.

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FRIDAY, OCTOBER 29th, 1926.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

NEXT WEEK.

TUESDAY, NOVEMBER 2ND, at 4.30 p.m. (Dominions and Colonies Section). SIR STANLEY BOIS, President of the Institution of the Rubber Industry, and Past Chairman of the Rubber Growers' Association, "The Importance of Rubber in Economic and Social Progress." SIR EDWARD ROSLING will preside.

Tea will be served in the Library at 4 p.m. before the meeting.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ORNAMENT IN BRITAIN.

By CHARLES REED PEERS, C.B.E., M.A., F.B.A.,

Director of the Society of Antiquaries and Chief Inspector of Ancient Monuments, H.M. Office of Works.

LECTURE II.—*Delivered April 26th, 1926.*

In the first lecture of this series I attempted to trace the course of ornament in prehistoric Britain down to the Roman occupation, with which our prehistory ends. The story was that of a series of influences travelling westward to our coasts, whether along the trade routes in the ordinary course of commerce, or by invasion, peaceful or warlike, of the migratory races of Europe. These various elements, destined in course of time to combine in the making of a race with definite character and outlook, produced according to the measure of their culture and force schools, if we may so

label them, of design which continued and developed to a greater or less extent, and in the last century before the Christian era had evolved an art of a really high decorative value, with a sense of line and of balance which need not fear comparison with anything which has succeeded it. But to the Roman conquerors of Britain it had no appeal: it was barbarian art, uncivilized and not able to stand against the organised classic arts of the Roman Empire. Latin civilization, efficient and fully developed, the inheritor of the highest traditions, had no place for it, and though traces of it may be found all through the 350 years of the Roman occupation, it is only as evidence that the province of Britain was at the limits of the Roman world, and was wont to betray its distance from the centre of things by a lower standard of achievement than would have satisfied Gaul or Spain. Not that the great towns of Roman Britain were lacking in fine and imposing buildings, whose stately ruins remained for centuries after the Emperor Honorius, husbanding the resources of his failing empire, "committed to the Britons the care of their own safety." Even in the 12th century there remained at the distant legionary fortress of Caerleon in South Wales "many vestiges of its former splendour, immense palaces, formerly ornamented with gilded tiles, in imitation of Roman magnificence, a town of prodigious size, remarkable hot baths, relics of temples and theatres, all enclosed with fine walls." So wrote Gerald de Barri in the time of Henry II. But even as the native art of Britain seemed alien and negligible to the Roman, so his own arts were and remained alien to Britain. What the Roman produced in Britain was Roman, provincial indeed but Roman, a thing imposed upon but never taking root in a foreign country. When he left Britain his arts were far in decadence, but showed no sign of fusion with the native arts, nor gave any promise of new development. The trappings of his civilisation he left behind him, indeed, to be used by those who were little capable of perpetuating them, but his arts went with him and left a void, leaving the land to resume the course he had interrupted three-and-a-half centuries before, and to follow the destiny which its geographical position had already in prehistoric times imposed upon it. The migrations, the folk-wanderings, of which we have records as far back as history can take us, were now, among the northern races, at their height. Long before the Romans left Britain the descents of the Saxons on our shores had been persistent enough to make an organised coast defence necessary, and when in the 5th century these defences were abandoned, it was only a question of time before the old conditions were reproduced. But this time a difference is to be noted. Former immigrations had been in essence the carriers of a more advanced culture; now the reverse seemed the case. But this was only a temporary phase, and the vigour of the newcomers was destined to carry forward to a higher plane, and at no distant date, the arts which they had seemed for the time to overwhelm.

With Angles, Saxons and Jutes settled in their new quarters their contributions to our record must be examined. The Teutonic arts which they brought offer an instructive parallel and contrast to those essays of the earlier barbarians which we have already considered. Broadly speaking, there seemed to be a sequence of point, line, spiral, curve in these primitive designs. From this arises pattern, and to it are added such definite symbols or figures as may be brought in by contact with more advanced nations. But we have now to do with a later stage in the world's history. Teutonic ornament is founded on animal forms, probably of Eastern origin, the significance of which seems soon to have been misunderstood, or at any rate ignored, and in order to fill up the spaces to which their ornament was to be applied, the animals are distorted, dismembered and transformed in a way which could hardly be believed if it were not possible to follow it step by step, and measure its gradual progress to unintelligibility. In the 6th century came

FIG. 1.

the adoption of the interlacing strands or braidwork which became so notable a feature of northern art, and are found either as pure plaits or combined with animal forms in endless variety for the next six hundred years at least. Such forms are entirely appropriate to the northern nations, but here again, as always, traces of classic motives will recur, to be assimilated and transmuted in the course of years as each craftsman continues the work of his predecessor. In the early days of the Teutonic occupation of Britain—early, that is, in the 6th century—a form of scroll ornament occurs which in its treatment seems to suggest an origin from woodcarving—the chip-carving or keilschnitt (Fig. 1), in which the pattern is outlined with V-shaped incisions like those of the chip-carved wood which occurs at all dates through the middle ages and down to our own days. The regularity of the treatment

offers suggestions of a classic restraint at times, and is specially adapted to the decoration of the saucer brooches, circular brooches which in some cases bear designs of definite classical origin, and may be considered as inspired in shape as in pattern by Roman models. The later examples, however, which go down to the middle of the 7th century, are frankly barbarian, following the uniform tendency of the times.

The same classical elements may be seen on an elaborate circular brooch of the first half of the 6th century, decorated with two zones of confronted beasts, found at Sarre in Kent. (Fig. 2). But the most attractive works of

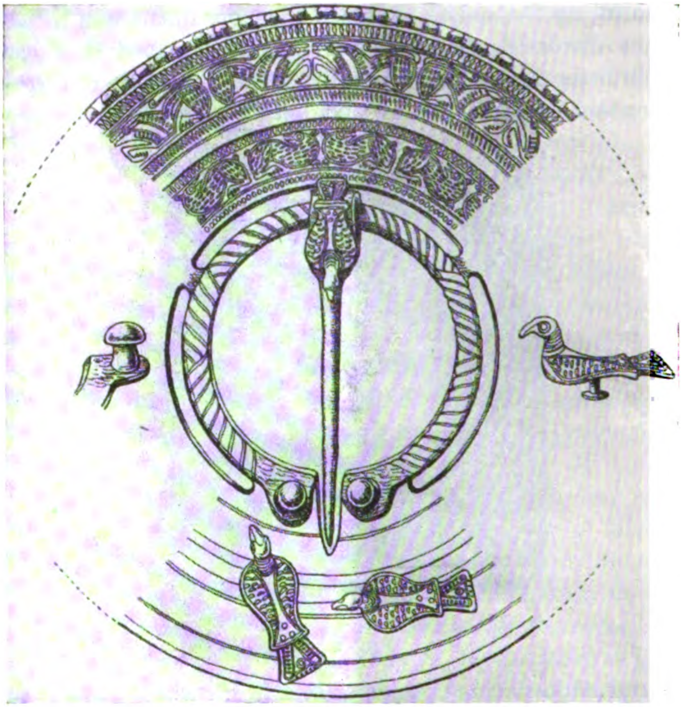

FIG. 2. Brooch from Sarre.

this time are the jewels with garnet inlay which are characteristic of Kent and the Jutish settlers there, dating from the sixth and early part of the seventh centuries. A pendant, enclosing a solidus of the Emperor Heraclius, is typical, and it is instructive to note that the maker, for all his admiration of the gold imperial coin, has set it upside down. (Fig. 3). Another has a coin of Valentinian and a third an imitation of a coin of Mauricius Tiberius. The same technique is to be seen on a buckle from the grave mound at Taplow, of early 7th century date, which is further decorated with filigree interlacing.

of good style and unusual character. (Fig. 4). Such interlacing is a feature of the fine Kentish brooches, which are at once the most attractive and the most carefully wrought of all the products of the time.

The more essentially barbarian side, the ornament composed of dismembered and contorted animals, is well seen on some types of the long brooches and of the so-called bracteates, thin metal discs which were originally copies of gold coins, used as personal ornaments. (Fig. 5). These dismembered beasts are of the essence of Teutonic ornament, and we shall see the tendency to use animals, as a race instinct, occurring at a later date.

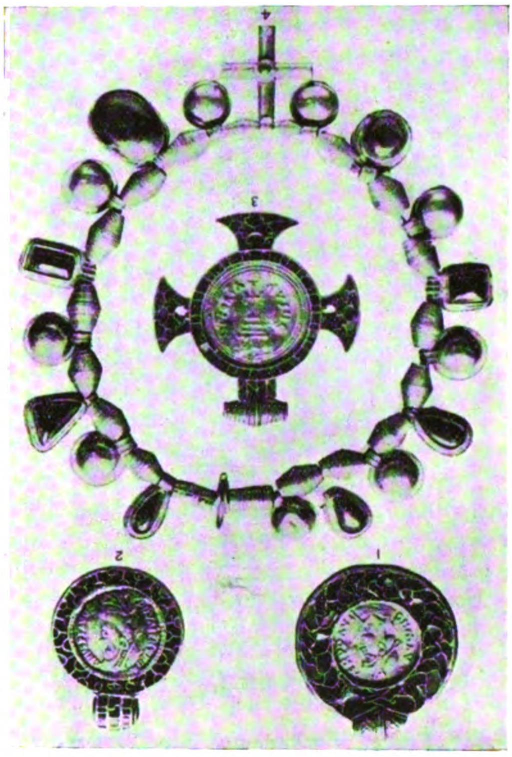

FIG. 3. Jewellery with garnet inlay.

What we have been so far considering belongs to the Pagan period. The reintroduction of Christianity into Britain, in the south at the end of the 6th century, in the north in the second quarter of the 7th, had a profound influence on the development of Saxon ornament, and this for two principal reasons. In the first place, it changed the customs, leading, for example, to the disuse of the practice of burying weapons, jewels and such like with the dead, and in the second place, the objects and forms of the new religion

were necessarily inspired from abroad, and notably from the centres of Christianity in Southern Europe. Thus, though it is not accurate to say that Christianity in itself was a creative force in Anglo-Saxon art, it may be held decisive for its development. The most striking manifestation of this may be seen in the story of the conversion of the Anglian kingdom of Northumbria. Here, in the time of King Edwin, a missioner from the south, Paulinus, had established himself in York, and met with considerable

FIG. 4. Buckles, etc., from Taplow.

success. But the death of the King at Heavenfield in 633 put an end to Paulinus' work, and for the moment the results of his mission were effaced. When in the next year the Anglian fortunes were restored by a victory, the reintroduction of Christianity came through Iona, the headquarters of the Irish mission to Scotland. Now Ireland in this and the next century was at the height of her powers in art, and employed in her ornament not only the zoomorphic and interlacing elements, but was the last home of that late-Celtic style which at the beginning of our era had produced such notable

works in Britain. It was a mere shadow of its former self, but the feeling for line and curve remained, and it seems fair to say that wherever it is found at this time, and till its final disuse about the end of the 8th century, it may be taken as a hall mark of Irish influence. Add to this that interlacing ornament in Ireland is of peculiar subtlety and accuracy, and an estimate of the part that Ireland played in the renaissance we have now to examine may be attempted.

From 635 to 664, the date of the Synod of Whitby, the influence of Iona, and therefore of Irish Christianity, in Northumbria, was preponderant. After that time, through the efforts of such men as Benedict Biscop and Wilfrid, the connexion with Rome was established, not only by visits to Italy, but by the introduction into Northumbria of foreign craftsmen and of foreign works of art. The result, as shown by the monmuents, was the

FIG. 5. Bracteate.

appearance of sculpture and ornament which added an entirely new element to the art of the country. Now Northumbrian monuments which are earlier than 664, the date of the Synod of Whitby, are rare: indeed, one can only claim with any confidence for this period some of the small gravestones bearing crosses found at Hartlepool and Lindisfarne, both monasteries founded under Irish influence. The drawing on these is fine and certain, though simple, and such stones are only found elsewhere in Iona, and especially in Ireland: their Irish origin may be claimed, and their special feature, the fineness of line, noted.

When we come to the two outstanding monuments of this period in Northumbria, the crosses of Ruthwell and Bewcastle, we meet with a new school, shown by figure sculpture and decoration alike of a very high order. The figure sculpture I must with regret leave without the detailed consideration which it deserves, as being outside the definitions which I put forward in my first lecture. And it must be added that it was beyond the powers of native artists to assimilate, and left no more than a passing effect. With the ornament it is otherwise. The characteristic motive is founded on

the vine. The vine scroll with or without ornament is of classic descent, and it will be sufficient for our purpose to see it on the chair of Archbishop Maximian at Ravenna, dating from the middle of the 6th century. The representation of vine and animals is easy and natural, and the relation between it and the ornament on English cross-shafts is obvious. But the differences are quite as obvious, and may be put shortly thus: that while the Ravenna carver knew all about vines, there is nothing to show that the Anglian carver had ever seen one.

You will also note on the Ruthwell vine scroll a certain insistence on the spiral of the stem, at the expense of the leaf and flower. The animals and

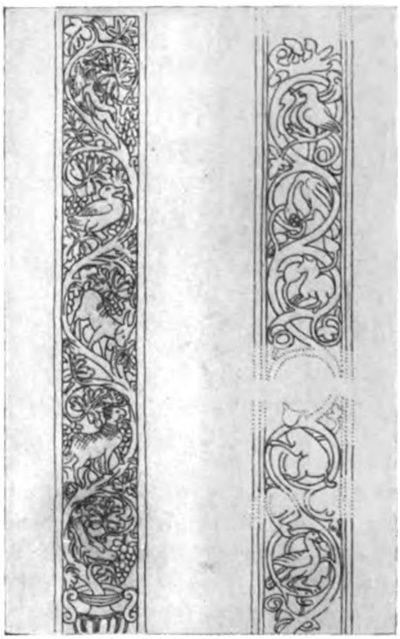

FIG. 6. Vine scrolls, Ravenna and Otley.

birds are admirable in themselves and in relation to the vine, but definitely less naturalistic than those at Ravenna.

Turn next to the Bewcastle cross, which from the inscriptions on it must have been set up where it now stands in the last years of the 7th century. The vine scrolls are there, but also there are other things not found at Ruthwell. There are panels of chequer work and interlacing—coming not from the same source as the vines and figure sculpture, but from nearer home. Their fineness and accuracy, moreover, is quite apart from anything that Teutonic art of the Pagan period has produced, but quite in keeping with the Celtic art of Ireland. Nearest to these two cross-shafts comes the

slab at Jedburgh, with a double vine and animals, and there can be little difference in date between these three monuments.

The vine without animals, on the Acca cross from Hexham, probably of early 8th century date, if compared with a like design from the Christian East, shows at a glance the same evidence that the Ruthwell cross showed, namely, the same unfamiliarity with the vine plant. This in a later development, also at Hexham, shows how in native hands this tendency will evolve. Let us now see how the vine with animals develops in Britain. A comparison of Ravenna with a shaft at Otley may come first. (Fig. 6). At Croft, near Darlington a shaft shows a more restless treatment of the creatures involved in the vine; then at Easby (Fig. 7) they seem to begin to dominate the ornament. At Aldborough (Fig. 8) the scroll begins to be merely accessory, and the animals not only begin to monopolise the panels, but occur in pairs, and in some cases develop interlacings on their own account. From this

FIG. 7. Cross-shaft at Easby.

the next step is to suppress the vine and give the animal the whole field, and by this the connexion between one beast and another disappears, and the shafts come to show a series of disconnected panels, one above another. So that we here see the Teutonic aptitude for animal ornament reasserting itself, though in a more sober and ordered form than before.

Not only so, but with a sense of beauty and line which is not foreshadowed by their early record. Whence does this come ?

For the answer we must turn to the examination of the third outstanding monument of the time, the Gospel book of Lindisfarne, written between 698 and 721 by the Saxon Eadfrith, Bishop of Lindisfarne. (Fig. 9). Here the Irish element is as dominant as is the classic at Ruthwell: but as there is a difference at Ruthwell from its prototype, so at Lindisfarne there is a restraint, a sobriety, which is not found in the contemporary Irish MS., the Book of Kells. Here then we seem to be able to appreciate the elements of the style of ornament which we have followed in its development: the sobriety

contributed by the Saxon blends with the fineness of the Celt to produce a character which, as I have had to note in my former lecture, seems to continue throughout our story: the character, in a word, of English art.

To take the story to the South. A psalter, written it is thought at Canterbury in the latter part of the 8th century, shows in its details the survival of Irish, that is, late-Celtic, ornament, and with it a classic treatment of obvious character. The treatment of the capitals and bases of the shafts carrying the enclosing arch is to be noted, and a comparison with a Merovingian MS., which is considered to be some half a century or so earlier, shows a connexion which is too near to be accidental. (Fig. 10). The birds on the

Fig. 8. Cross-shaft at Aldborough.

capitals and the pairs of beasts on the bases are clearly the same, except in their treatment. There can be no two opinions which are the better drawn; the copy excels the original. There is, unfortunately, for this period a distinct lack of examples from Southern England, but the greater facilities for intercourse with the continent, joined to the Irish element, to which the MS. itself witnesses, are the factors which must be taken into account. That the vine scroll is not so much in evidence is perhaps only an accident of non-survival: it occurs in the fragments of a very important cross at Reculver, which has not received the notice it deserves, and on work of later date at Ramsbury, in Wiltshire.

FIG. 9. Page from the Lindisfarne Gospels.

An ivory casket, now at Brunswick, but from its inscription made for the monastery at Ely (Fig. 11), will carry on the story as shown on the cross-shafts. The pairs of beasts involved in interlacings are to be noted, and especially the panel with Irish spirals. This should imply an 8th century date, which

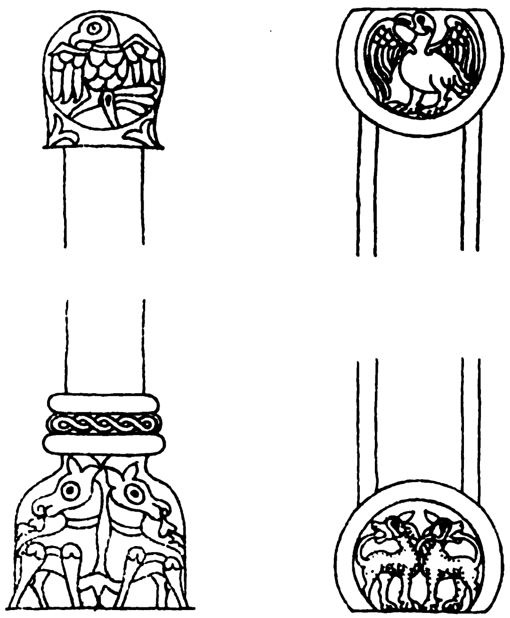

FIG. 10. Merovingian and South English work contrasted.

FIG. 11. Casket from Ely.

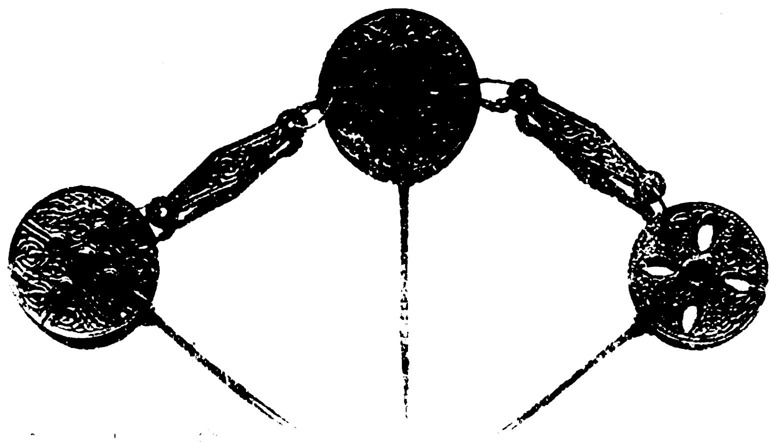

FIG. 12. Pins from the Witham.

may well be the case, and the fantastic treatment of the beasts carries out the theory of development suggested.

Now if the theory of assimilation and selection, leading to a native art gradually developing on definite lines, is to be upheld, it would seem that by the 8th or early 9th century, on historical grounds, there should in Britain be evidence of an Anglo-Saxon school. And I think it can be demonstrated.

Three conjoined disc-headed pins found in the River Witham show fine interlacing with subordinated animals, and may date from about 800. (Fig. 12). This seems directly to carry on the line, and to contain no element that is not in the style. The important find at Trewhiddle in Cornwall, important

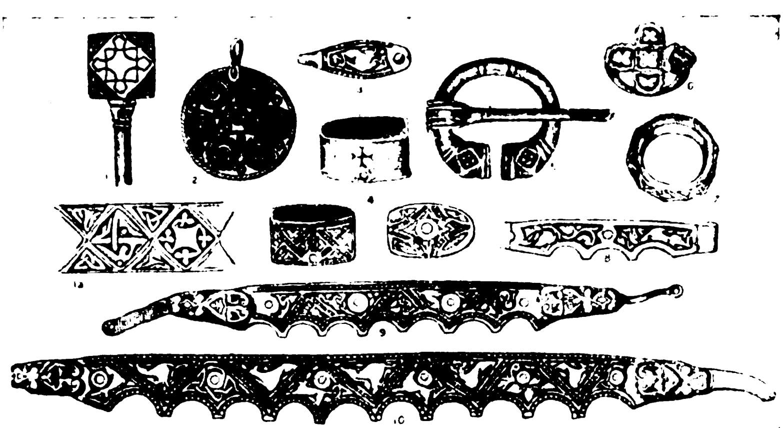

FIG. 13. Objects from Trewhiddle.

because it can be closely dated to c. 875, shows animals of the same character, combined with pellets and leaf ornament, though here the interlacing is subordinate. (Fig. 13). The handle of a sword found at Wallingford has silver ornament with animals, clearly akin to the former, but its leaf ornament has a new element, which fitly introduces the next phase in the story.

I have ventured to use the word renaissance in connexion with Northumbria in the 7th century, but the word should perhaps be reserved for that revival of classic art connected with the name of Charlemagne—a revival in part political, but none the less effective, which had as great an influence on mediæval art as the later Italian renaissance had on modern art. If one may hazard a generality, the 7th century gave us the vine,

FIG. 14. From King Edgar's Charter to New Minster.

but the Carolingian 9th century school gave us the acanthus. The story of the invention of the Corinthian capital from a castaway basket round which an acanthus plant had grown need not be insisted upon, except for its recognition of the decorative value of the plant. The acanthus-leaf capital had a long vogue, and an immense influence on leaf ornament. The stiff stalked leaves and deeply cut foliage were endlessly developed, and the leaves on the Wallingford hilt may be taken, for us, as a landmark and due to Carolingian influence. The close connexion of Britain with Charle-

magne needs no argument. The story of his request to Alcuin to obtain for him from England young men proficient in the arts for the instruction of his craftsmen is well known, and Alcuin's position at Charlemagne's court is in itself sufficient witness. The adoption in this country of the Carolingian monetary unit, the silver penny, testifies to the relations with the Empire, and the coinage of Offa of Mercia, the most able native prince of his day, with its remarkable portrait of the king, points in the same direction.

The ornament in English MSS. from the 10th century onwards derived directly from Carolingian sources, and its significance, as far as we are concerned, is of capital importance. We may definitely speak of it as Romanesque

Fig. 15. Bronze from Thames, near London.

Fig. 16. Brass plate from Winchester.

in the conventional application of the word. From it a line of development leads unbroken to our 12th and 13th century leaf-ornament. It is only necessary to recall the ornament on King Edgar's charter to the New Minster at Winchester, dated 966 (Fig. 14), and to follow it in MSS. of the schools of Winchester and Canterbury, dating from the end of the 10th to the middle of the 11th centuries.

Here, then, we see a continuous tradition. Its very continuity is illuminating. The story of England, from the third quarter of the 9th century

onwards, is that of a long and bitter struggle against raid and invasion. The descendants of the invaders of the 5th and 6th centuries have now to grapple with other invaders. Nearly the whole country is overrun in the late 9th century, and only partly recovered by King Alfred. The invaders remain as settlers, only to be succeeded by more invaders, and early in the 11th century the whole kingdom comes under Danish rule.

What record on the monuments of the country is left to witness to this? As far as MSS. are concerned, there is nothing to show. They are, we may perhaps say, in a special class, and not such work as would be produced in the small towns and villages.

The simplest ornament of the times, from the 9th century onwards, is the interlacing work, which in varying degrees of skill is found in all parts of the country.

Side by side with it, but in very low numerical ratio to the native Saxon work, designs of definite Scandinavian style from this period are to be found in England. That they are aliens one glance is enough to show. Two stones from Bibury in Gloucestershire, a bronze model of a gravestone from the Thames near London (Fig. 15), an engraved brass plate from Winchester (Fig. 16), and an inscribed gravestone from London, are all of the late Scandinavian school, and due, we must infer, to foreign craftsmen. There is yet a third class, on which the influence of Scandinavian art can be claimed, but anything like a fusion of style is not to be demonstrated. The events of the 11th century, as you need not be told, turned the course of our story in another direction.

NOTES ON BOOKS.

A Text-Book of Inorganic Chemistry. By Dr. Fritz Ephraim, Professor of Chemistry, University of Berne. English edition by P. C. L. Thorne, Lecturer in Chemistry, Cass Technical Institute. London: Gurney and Jackson. 28s. net.

Author and translator, each speaking from a chair of authority, agree in presenting this work as an improvement on the present-day systems, whether as regards conciseness, ease to reader, wealth of material, or convenience for reference, pp. V. to VII. The prefatory matter also includes some notes as to dealing with unconnected facts and "treating related compounds together."

The real basis of the innovation is not wholly obvious at first sight, but it appears to include making the electro-negative part of each compound the leading idea in classification; this bringing compounds into extensive classes as, for example, oxides, sulphates, or halides: see note at top of p. 789. Our first effort to understand the system was to learn how the author touches on the occurrence in nature and general properties of the elements; silver having been mentally selected as a test element. The index, whether under elements or silver, gives but scant aid. "Silver properties" directs us to "Elements," where we find "Elements, properties, 23"; but on p. 23 all we see of silver is Ag as one position in a graph. "Elements,

preparation of " guides us to a sequence of paragraphs pp. 99 to 166 touching mainly on reactions, in which the elements are liberated and concluding with the noble metals classed together, but sources and general properties, as looked for in an ordinary English text-book, are not given.

The book commences with speculation : facts and experimental details coming afterwards, the usual order being thus reversed. The theory is mainly the outcome of that new aspect of orbital atomism which has arisen out of, or followed from, Becquerel's observation, made in 1896, that a uranium salt may emit a kind of radiation which can penetrate certain materials, that are ordinarily regarded as opaque.

This new atomism, which our author seems so literally and so unreservedly to accept, appears to be fundamentally similar to the atomism of Boscovich which is presented to us on pp. 34-50, also 430-431, and 465-470 of the 2nd edition of Daubeny's Treatise on the Atomic Theory (Oxford: University Press, 1850). Daubeny first gives his own account, which he appears to have taken directly from the *Philosophiae Naturalis Theoria*, of Boscovich, 1759 edition, and afterwards he gives the views of Mason Good, Faraday, Priestley, and Davies Gilbert. The aim of Boscovich is to show mathematically that extension and weight may belong to a body taken collectively even when not predicated of the component parts. Thus he gives effective or virtual mass to the monads of Zeno, Moschus or Pythagoras, even though these monads may be defined as infinitely small; that is, less than any magnitude which can be stated. As in our system of the last 30 years, motion under opposing stresses is the added factor which determines the new weight and extension. The non-orbital aspect of the Boscovich system, represented by Daubeny as a figure on his p. 37, is of interest as perhaps leading to a simplified concept of all that Dr. Ephraim embodies in his Fig. 1, p. 4.

As an effort to co-ordinate the periodic classification of Newlands and Mendelejeff with present-day views of atomic structure the tabulation on p. 7 of the work under notice is instructive and highly satisfactory, the serial numbers of the periodic system being considered in electronic structure, and in relation to that which the author terms "the building up of new shells," p. 8. The word "shell" used in this atomic sense may perhaps appear a little too crude and materialistic for the strict or matured language which we expect in a scientific text-book, although the writer of a research paper may be allowed the use of " shell " in a preliminary sentence to help in leading the mind towards a more geometrically and literally exact expression like " level " as used by Rutherford : *i.e.*, " level " in relation to an assumed nuclear position (eighth Trueman Wood Lecture : *Journal*, May 13, 1925, p. 392).

The atomic illustration, Fig. 1, p. 4, is given by the author as a diagrammatic scheme to aid imagination in realising Bohr's views as to sudden changes in orbit of the single electron attributed to the hydrogen atom, especially as bearing on Planck's quantification, light spectra, and x-ray spectra. In the verbal regions linking this diagram with the periodic table on page 7, there are certain rather questionable expressions as " a layer of electrons " p. 2. The orbital electron being by hypothesis a minute primordial negatively charged motile mass cannot be regarded as one of a layer.

Reverting to strictly chemical or experimental aspects we turn to p. 100 to learn something as to the liberation of hydrogen from acids by metals. This page is headed by a voltage table with numerical values, which is followed by some pages of deeply interesting text in which one finds many new views ; also broad generalisations, and unexpected notes on established facts like that on p. 102 as to " sprouted

alumina." The voltage table shows us quite definitely which metals ought to liberate hydrogen according to that aspect of theory which inspires the table, and an interesting account is given of such liberations. We, however, failed in a search for mention of the liberation of hydrogen by the action of aqueous hydriodic acid on silver, mercury or palladium: facts inconsistent with the author's absolute and strictly numerical concept of a normal potential series as embodied in his voltage table. A thoughtful chemist, however, who looks back on Faraday's tabulated permutations with metals and electrolytes (which include a system of two metals and electrolyte in which dilution reverses the polarity), may see facts from a standpoint slightly different from that of the author. After a period of nearly a hundred years from the tabulations of Faraday, it is instructive to turn to the July, 1926, issue of the Chemical Society's Journal, and to read from p. 1872 to 1893, a remarkable final item being the voltaic cell of Mr. Hedges which gives an alternating current, pp. 1892-1893.

The method or order of this book involves the rejection of much of Bacon's teaching, also the casting aside of that easy psychological sequence of our text-books which has led us by experiment from natural products and obvious forces to the utmost complexities of the chemical art, whether in practice or in theory. The author takes us back to the spirit of the later middle ages, where extreme generalisation inevitably leads to a trace of slackness or uncertainty in wording, and giving priority to theory tends towards a subordination of experimental facts. As a result we have a book which fascinates at the first glance. Everyone interested in chemistry should study the book and judge for himself as to the system.

Kaytex Code. Compiled by Max M. Kay. Manchester: Kay's Code Co., Ltd.

This code has been designed specially, but not solely, for the textile trade. It has been constructed on the simplest lines for the senders of messages, and contains upwards of 95,000 phrases, 10,000 numerals in sequence, and 2,000 blanks.

The Compiler, himself an exporter of textiles, has had the advantage of daily seeing messages set up by other codes, and has been able to remedy the defects found in other works. An ingenious method of allowing any series of numbers, sizes, and other figure matters to be cabled in the minimum number of words is a special feature of the Kaytex Code, which has also adopted a new way of arranging the sentences under the various main heads or guide-words. There are a number of Tables, by means of which two or even three items are cabled at the cost of half a word, and when it is remembered that many messages cost three shillings per word, it will be recognised that in every direction economy can be effected. All through the code, any reference to previous telegrams is made to specific half words and not full words, for by this means one is able to identify definitely the particular item in the telegram under reply, to which reference is being made. It has sometimes been difficult in the past to know to which of the two cyphers in the particular word the reply is referring.

CHEMICAL RESEARCH IN GERMANY.

The Commercial Secretary to H.M. Embassy in Berlin states in his recent Report that the importance of research work in the chemical industry of Germany is well appreciated and there is to be observed a continuous and logically directed investigation into the production of oils and fuels from coal and coke by the methods of liquefaction and synthesis.

The experiments of Bergius on liquefaction, extending over many years of research, are sufficiently well known in scientific circles. Geheimrat Fischer, of the Kaiser Wilhelm Institute for Coal Research, is reported to have achieved certain initial success in the synthesis of liquid fuels from the gasification products of coal and coke under comparatively low temperatures and pressures. Concurrently, the Dye Trust, which has gained exceptional experience in high-pressure technology notably in the sphere of the manufacture of synthetic nitrogen, is also engaged very actively in research work upon the production of liquid fuel by catalytic action, and has already attained definite success in the production of synthetic methyl alcohol from water, gas and hydrogen, which process has now for some time been operating on a commercial scale.

Whilst it is too early yet to speak of practical successes in these fields of investigation, it must be emphasised that the very intense investigations which have been carried out have certainly gone to pave the way for a future solution, and the results have enabled research to be guided into channels offering some promise of success.

It has been stated by Dr. Spiller at the annual meeting of the Association of German Chemists that it has now been decided to lay out in the Ruhr the first large installation utilising the Bergius process, and it would appear that the continued researches carried out upon the constitution of lubrication oils have renewed hope that the hydration of coal and tars holds out prospects of commercial success in the production of lubricant and lighter fuels.

From time to time rumours are current, that, now in one direction, now in another, success has been achieved or that scientific investigations have advanced to the point of emerging from the laboratory and being applied on a practical scale. These rumours may prove unfounded or exaggerated, but the work of research goes steadily on, and the scope of enquiry becomes increasingly widened by the added resources which this interesting field of study is constantly attracting.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 1..Chadwick Public Lecture, at ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8 p.m. Sir Robert Greig, "Deficiency Diseases of Animals in Relation to Public Health."

Chemical Industry, Society of, at Burlington House, Piccadilly, W.1. 8 p.m. Dr. Herbert Drake-Law, "Artificial Colours used in Foodstuffs."

Child-Study Society, at the Central Hall, Westminster, S.W.1. 6 p.m. Sir M. E. Sadler, "Sandford and Merton."

Engineers, Society of, at Burlington House, W. 5.30 p.m. Miss A. Ashberry, "Some Products of a small Machine Shop."

Farmers' Club, at 12, Great George Street, S.W.1. 4 p.m. Mr. S. Street-Porter, "Poultry on the Farm."

Royal Institution, Albemarle Street, W. 5 p.m. General Meeting.

Société Internationale de Philologie Sciences et Beaux Arts, 8, Taviton Street, W.C. Major R. Rigg, "Some Thoughts of Mediæval London."

Transport, Institute of, at the Institution of Electrical Engineers, Victoria Embankment, W.C.2. 5.30 p.m. Annual General Meeting. Mr. C. S. Page, "Docks in Relation to Railways."

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Prince D. Svyatopolk Mirsky, "The Great Russian Poets." (Lecture IV.)

At King's College, Strand, W.C.2. 5.30 p.m. The Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture II.)

At University College, Gower Street, W.C.1. 5.30 p.m. Signor Camillo Pellizzi, "Franciscan Thought in the Middle Ages."

TUESDAY, NOVEMBER 2..Anthropological Institute, 52 Upper Bedford Place, W.C. 2.30 p.m. Mr. A. Leslie Armstrong, Presidential Address, "The Grime's Graves Problem;" 8.30 p.m. Mr. E. S. Thomas, "A Comparison of some North African and South Spanish Designs." (Joint Meeting with the Prehistoric Society of East Anglia.)

Arts, Royal Academy of, Burlington House, Piccadilly, W.1. 4.30 p.m. Prof. Arthur Thomson, "The Essential Features of the Face, Head and Neck." (Lecture IX.)

Civil Engineers, Institution of, Great George Street, S.W.1. 6 p.m. Ordinary Meeting.

Electrical Engineers, Institution of, at 17, Albert Square, Manchester. 7 p.m. Mr. W. J. Medlyn. Chairman's Address.

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Dr. L. Aitchison, "Light Alloys."

Royal Institution, 21, Albemarle Street, W.1. 5.15 p.m. Dr. G. W. C. Kaye, "The Acoustics of Public Buildings." (Lecture I.)

Transport, Institute of, at the University, Bristol. 5.30 p.m. Mr. R. G. Pittard, "Schedules, Time-tables and Duties of a Road Undertaking."

At the Imperial Hotel, Birmingham. 6.30 p.m. Mr. J. A. Dunnage, "Revolutionising Transport."

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 3 p.m. Prince D. S. Mirsky, "The Russian Literary Language."
5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture IV.)
At King's College, Strand, W.C.2. 5.30 p.m. The Rev. Percy Dearmer, "Spanish Art." (Lecture IV.)
5.30 p.m. Professor Dr. C. Lloyd Morgan, "The Place of Mind in an Organic Theory of Nature." (Lecture III.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5.15 p.m.
"Accounting in Public Offices." (Lecture V.)
At the School of Oriental Studies, London Institution, Finsbury Circus, E.C.2. 5 p.m. Dr. L. D. Barnett, "An Introduction to Indian Philosophy." (Lecture II).

Zoological Society, Regents Park N.W. 5.30 p.m. Meeting for Scientific Business.

WEDNESDAY, NOVEMBER 3..Analysts, Society of Public, at Burlington House, Piccadilly, W.1. 8 p.m. (1) Dr. W. R. Schoeller and Mr. C. Jahn, "Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates. VI.—The Precipitation of the Earth Acids by Sodium Compounds. (2) Mr. A. E. Parkes, F.I.C., "A Simple Method of Testing for the Presence of Sulphites in Foods." (3) Mr. J. W. Haigh Johnson, "A Critical Review of the Methods of Analysing Waters, Sewages and Effluents, with Suggestions for their Improvement."

Archæological Institute at Burlington House, Piccadilly W.1. 5 p.m. Mr. Aylmer Vallance, "Looking for an Old Country House."

British Acetylene and Welding Association, at the Old Colony Club, Aldwych House, Aldwych, W.C.2. 8 p.m. Mr. Samuel Fox, "Oxy-Acetylene Welding as applied to the Construction of Boilers for Central Heating, etc." (illustrated by lantern slides).

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C.2. 6 p.m. Wireless Section Meeting. Chairman's Inaugural Address.

Geological Society, Burlington House, W. 5.30 p.m.

Heating and Ventilating Engineers, Institution of, at Caxton Hall, Westminster, S.W.1. 7 p.m. Mr. W. E. Fretwell, "Small Hot Water Supply Systems."

University of London, at King's College, Strand, W.C.2. 5.30 p.m. Sir Israel Gollancz, "Chivalry in English Poetry."
At University College, Gower Street, W.C.1. Signor Camillo Pellizzi, "Dante e la Commedia nel giudizio dei contemporanei." (Lecture III.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 6 p.m. "Office Machinery." (Lecture V.)
At University College, Gower Street, W.C.1. 5.30 p.m. Mr. J. H. Helweg, "Hans Christian Andersen." (Lecture III.)

THURSDAY, NOVEMBER 4..Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C.2. 7 p.m. Mr. G. F. Mucklow, "Hydrogen as an Auxiliary Fuel for a Solid Injection Engine." (Joint Meeting with the Institution of Automobile Engineers.)

Antiquaries, Society of, Burlington House, Piccadilly, W.1. 8.30 p.m.

Auctioneers' and Estate Agents' Institute, 29 Lincoln's Inn Fields, W.C. 7.30 p.m. Mr. W. S. Edgson, "A Few Impressions of Real Estate in America."

Chemical Society, Burlington House, Piccadilly, W.1. 8 p.m. (1) Messrs. C. K. Ingold and P. G. Marshall, "The Structure of the Benzene Nucleus. Part V.—Some Meso-derivatives of Anthracene." (2) Messrs. W. Wardlaw and R. L. Wormell, "The Isomerism of Molybdenyl Monochloride." (3) Mr. R. F. Hunter, "The Unsaturation of Heterocyclic Ring Systems. Part I.—The Benzthiazole and 1:2 Dihydrobenzthiazole System." (4) Messrs. R. F. Hunter and H. Morland, "The Unsaturation of Heterocyclic Ring Systems. Part II.—The 2- imino 4-keto Tetrahydrothiazole System." (5) Messrs. G. M. Dyson, H. J. George and R. F. Hunter, "The Inhibitory Effect of Substituents in Chemical Reactions. Part I.—The Reactivity of the Nitrogen Atom in Substituted Arylamines."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C.2. 6 p.m. Messrs. J. R. Beard and T. G. M. Haldane, "The Design of City Distribution Systems, and the Problem of Standardization."

Linnean Society, Burlington House, Piccadilly W.1. 5, p.m.

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. H. Avray Tipping, "Early Georgian Interiors."

Mechanical Engineers, Institution of, at Manchester. Mr. Robert Lowe, "Steel Castings in Mechanical Engineering."

Metals, Institute of, at the Royal School of Mines, South Kensington, S.W.7. 7.30 p.m. Dr. A. G. C. Gwyer, "The Structure and Properties of the Aluminium-Silicon Alloys."

Royal Institution, 21, Albemarle Street, W.1. 5.15 p.m. Sir Edgeworth David, "Exploration and Problems of Antarctica." (Lecture I.)

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Baron A. F. Meyendorff, "Russian Thought on Problems of Ethics." (Lecture IV.)
At King's College, Strand, W.C.2. 5 p.m. Dr. C. Da Fano, "Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System." (Lecture V.)
5 p.m. Dr. A. W. Pollard, "Bibliographical Evidence." (Lecture I.)
5.30 p.m. Mr. J. E. Barnard, "The Application of Microscopical Methods to Medical Research."
5.30 p.m. Mr. Ifor L. Evans, "The Economic Organisation of the Danubian Lands—1878-1914." (Lecture II.)
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5 p.m. Professor G. Salvemini, "Economic, Social and Political Life of the Italian Communes in the Thirteenth Century." (Lecture V.)
5 p.m. Professor A. J. Toynbee, "Aspects of International History since the War." (Lecture III.)
At University College, Gower Street, W.C.1. 4.15 p.m. Prof. F. Y. Eccles, "Bossuet." (Lecture IV.)
5.30 p.m. Prof. F. C. Burkitt, "The Study of the Sources for the Life of St. Francis."
5.30 p.m. Mr. Prynce Hopkins, "The Motivating of Conduct."
5.30 p.m. Prof. J. E. G. de Montmorency, "Legislative Tendencies in the English Speaking World." (Lecture III.)

FRIDAY, NOVEMBER 5..Academy, British, at Burlington House, W. 5 p.m. Prof. R. W. Chambers, "The Saga and Myth of Sir Thomas More."

Arts, Royal Academy of, Burlington House, Piccadilly W.1. 4.30 p.m. Prof. Arthur Thomson, "A Rapid Survey of the Main Features of the Lower Limb." (Lecture X.)

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Prof. Dr. E. G. Coker, "Elasticity and Plasticity." (Thomas Hawksley Lecture.)

Transport, Institute of, at the Town Hall, Leeds. 7 p.m. Mr. C. Travis, "Railways of Australasia."

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Dr. R. W. Seton-Watson, "Austria under Francis and Metternich." (Lecture III.)
At King's College, Strand, W.C.2. 5.30 p.m. Dr. W. T. Gordon, "Swiney Lecture." (Lecture I.)
At University College, Gower Street, W.C.1. 5 p.m. Mr. R. K. Cannan, "Biological Oxidation—Reduction." (Lecture V.)

SATURDAY, NOVEMBER 6..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. C. Daryll Forde, "Weather Forecasts and the Weather."

Royal Institution, 21, Albemarle Street, W.1. 3 p.m. The Rev. E. M. Walker, "The Study of History." (Lecture I.)

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FRIDAY, NOVEMBER 5th, 1926.

All communications for the Society should be addressed to the Secretary, John Street Adelphi, W.C. (2.)

NOTICES.

OPENING OF THE 173rd. SESSION.

The Opening Meeting of the 173rd Session will be held on Wednesday, November 10th, when the Inaugural Address will be delivered by SIR THOMAS HENRY HOLLAND, K.C.S.I., K.C.I.E., D.Sc., LL.D., F.R.S., Rector of the Imperial College of Science and Technology, Chairman of the Council of the Society. The subject of the address will be "International Interests in Raw Materials." The Medals awarded for papers delivered during the Session 1925-26 will also be presented at the Meeting. The Chair will be taken at 8.0 p.m.

Tea and coffee will be served in the Library after the Meeting.

Other meetings of the Society will be held in accordance with the announcements printed in the Programme of Sessional Arrangements, copies of which have been posted to all Fellows of the Society.

INDIAN SECTION.

A Meeting of the Indian Section will be held at 4.30 p.m. on Friday, November 12th, when a paper on "The Report of the Indian Currency Commission" will be read by Sir JAMES B. BRUNYATE, K.C.S.I., C.I.E. MR. F. C. GOODENOUGH, Member of the Council of India and Chairman of Barclay's Bank, Ltd., will preside.

Tea and coffee will be served in the Library from 4 p.m.

SPECIAL MEETING.

TRUEMAN WOOD LECTURE, 1926.

WEDNESDAY, OCTOBER, 27th, 1926. SIR THOMAS HENRY HOLLAND, K.C.S.I., K.C.I.E., LL.D., D.Sc., F.R.S., Chairman of the Council, in the Chair.

The Trueman Wood Lecture on "The Progress of Economic Entomology (with special reference to Australia and New Zealand)" was delivered by PROFESSOR R. J. TILLYARD, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.R.S., F.L.S., F.G.S., F.E.S., C.M.Z.S., F.N.Z.Inst., Chief of the Biological Department, Cawthron Institute, Nelson, New Zealand.

The lecture will be published in the *Journal* dated November 12th.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ORNAMENT IN BRITAIN.

By CHARLES REED PEERS, C.B.E., M.A., F.B.A.,

Director of the Society of Antiquaries and Chief Inspector of Ancient Monuments, H.M. Office of Works.

LECTURE III.—*Delivered May 3rd*, 1926.

To carry on the story which the two preceding lectures have set forth it is necessary at the beginning of the concluding lecture to retrace our steps, and go once more over the ground already covered. The Carolingian renaissance of the 9th century is of the greatest significance in more ways than one. By its deliberate adoption of classic forms, and its pretensions to renew and to appropriate to itself the great traditions of Imperial Rome, it provided a central point, a standard of culture for the western world—a place where northern and southern might meet, to their mutual instruction and profit. And not least of its manifestations was its revival of the art of architecture. When Charlemagne built his great tomb-chapel of Aachen, he was consciously reviving the Roman tradition which Theodoric had himself perpetuated at Ravenna. And the desire for great buildings is one which easily takes possession of a nation or an age. From this beginning, we may say, the great school of Northern Romanesque art developed, awakening in the minds of men a passion for splendid building which was to dominate their whole conceptions, so that everything came to be set forth in terms of architecture. The contrast is significant. At the beginning of this enquiry we saw primitive ornament finding its starting point in the decoration of pottery—thence it spread to metal, used for itself or as a base for applied enrichments; thence to stone and parchment: in all cases following the same premise, that the material employed was to be considered as a vehicle for ornament. But with the growth of building the position is reversed and ornament becomes the handmaid to the mistress art of architecture, and is subordinated to architectural form, and that to such a degree that

when applied to other materials it preserves the form and character of masonry architecture as if the designer could think in no other idiom. Now with regard to Britain, it must be recognised that for the first two centuries of the Carolingian era materials are scanty in the extreme. The greater buildings of the later Anglo-Saxon times exist for us in records only: a clean sweep has been made of them, and from the fragments that have survived, no confident estimate can be made of their actual merits; but we must be particularly careful not to form too low an estimate. At the end of my last lecture I drew your attention to the three elements in the ornament of the 11th century: the interlacings, now generally of simple and unambitious character, the Scandinavian scroll patterns, and the acanthus leafage of Carolingian inspiration. Under the last of the Saxon Kings, Edward the Confessor, we may see the foreshadowing of one more development. The descendants of the Northmen, who under Rollo had established themselves in Northern France at the beginning of the 10th century, were now playing no inconsiderable a part in the affairs of Europe. Saxon England, after so many troubled years, seemed to have little of the vigour of her neighbour across the narrow seas, and partly by the force of circumstances, partly by the tendencies of her King, was irresistibly drawn within the orbit of Norman influence. We are told that the coming of the thousandth year of the Christian era had been awaited with many forebodings. Prophecies of the approaching end of the world, which at all times in our history are apt to occur on the slightest provocation, had not unnaturally been much in evidence as so notable a landmark in time drew near. When the great day had come and gone without disaster, the sense of relief was correspondingly great, and all men set about the affairs of life with renewed energy. Particularly was the effect on building emphatic, and in the words of the monk of Cluny, all Christendom began to put on a new white vesture of churches. The vigour of the Normans found a congenial outlet in such a task, and the extraordinary growth of monastic fervour gave ample scope for their constructive powers. So that when by the fortune of war the Norman Duke became the English King, and the centre of his power crossed from Normandy to England, all things combined to bring about such an orgy of building as the world has seldom seen. The Saxon cathedrals and abbey churches for the most part disappeared and were replaced by greater, and everywhere the works of the conquerors dominated the country. But though the order of things was new, it was not in essence alien. The common stock was northern, and time alone was needed for its fusion under the influence of the soil into a people of definite nationality. This is the great significance of the Norman Conquest. The divisions of the Heptarchy had long ceased to exist, and Anglo-Saxons and Danes were united under a King of England, but the strong rule of the Normans was of incalculable value in organising that unity. From this time we may see the conscious

growth and development of the nation as a nation, and, what is of equal significance, as one of the family of nations. Our immediate purpose to-night is to examine the effect of this on the national art, and to see how faithfully it is reflected therein. We have already noted how the successive external influences have been modified or transformed, and how certain elements tend to survive and others to disappear. And from a consideration of each example we have seemed to recognise an underlying principle, making for simplicity and sobriety, and with a sense of beauty which within the limits of the craftsman's skill is a sovereign antidote against the fantastic coarseness of other northern schools. But when all is said the story has been one of evolution rather than of expansion and development. While the treatment may be distinctive, the art itself seems to lack permanency. With the coming of the Normans all is changed. True, the seeds of the new order of things had been long sown, from the time when the Carolingian renaissance had made itself felt, but now we may begin to see a people taking charge of its own artistic destiny.

Fig. 1. Staffhead from Alcester.

In the century preceding the Conquest the vitality of ornament lies in the acanthus foliage of Carolingian descent. It will be enough to recall to you two examples from MSS.: one of the beginning of the 11th century, and one of the middle, described in the preceding lecture. And I will ask you particularly to note the strong stalk and lobed ends of the leafwork, for this is now at the beginning of a long journey, of which every step can be traced. It may be seen at its best on a fine ivory staffhead, found at Alcester in Worcestershire (Fig. 1), of admirable Carolingian art, but not, I must add, certainly of English fabric. How far this ornament was represented on contemporary architecture in England cannot, for the reasons already given, be demonstrated. Such 10th and 11th century work as remains is generally very plain and unornamented, and a foliate capital from Sompting, in

Sussex, shows little skill in design or execution. The standard of Norman ornament at the time of the Conquest gives evidence of a fine architectural sense, but uncertain execution. The chapel in Durham Castle was built within ten years of the Conquest, and its capitals show angle volutes of satisfactory design, but subject carvings of very rude execution. The variety of design in Norman capitals is great, and the purely architectural forms must be passed over, as well as those having figure subjects. One from Christchurch, Hants., c. 1120, may be, perhaps, ranked as ornament, though not schematic, but a regular acanthus and volute type from the same church is in the true line of development. A vine pattern from Old Sarum, c. 1140, is a simple form of what is usually more involved, and the paterae and acanthus string course from the same place are somewhat exceptional. (Fig. 2).

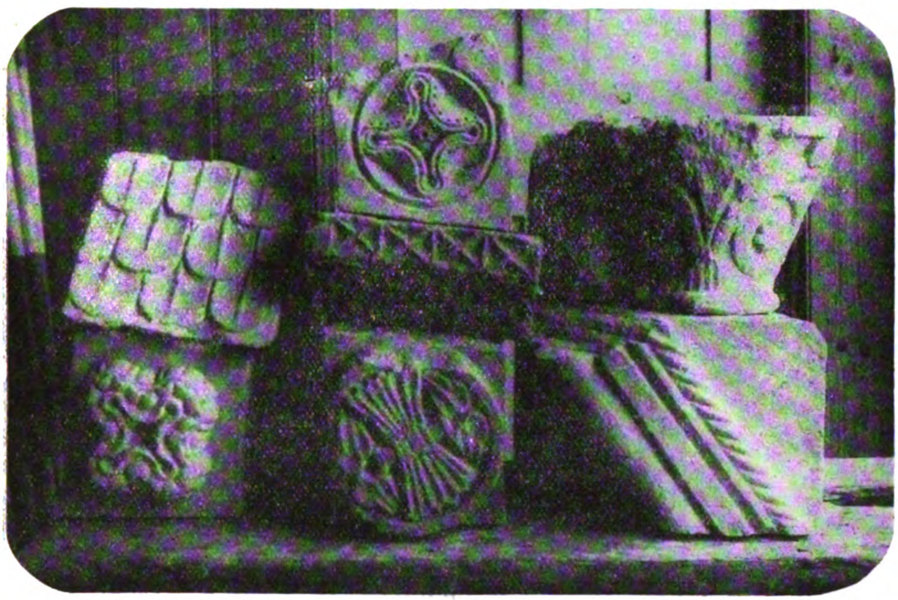

FIG. 2. Ornament from Old Sarum.

St. Peter's, Northampton, c. 1160, shows interlacing foliage and animals in scroll work, which are a long way from their Northern predecessors, and the door of Liverton Church, Yorks., shows interlacings and leaf-work of provincial and probably late character. New Shoreham, Sussex, c. 1180, shows the acanthus and the stiff stalk foliage ending in knobs, leading over to the normal 13th century form. The flat volute foliage, of plain character, c. 1190, develops into more leaf-like forms before being absorbed into pure leaf work, but is all in the line of growth, leading up to the great outflowering of the 13th century, which carries us directly to the high-water mark of English ornament.

Turning now to ornament as applied to arches, the zig-zag ornament, so characteristic of the time, does not, for all its long ancestry in primitive decoration, appear before the first decade of the 12th century. A rich but simple form occurs at Ely Cathedral, c. 1140 (Fig. 3), and is delightfully displayed in the Galilee at Durham, c. 1175. Combined with the lozenge, as at Castle Rising and Lilleshall, c. 1180 (Fig. 4), it is extraordinarily effective by the variation of its planes. A kind of epitome of arch ornaments occur on the fine, though much distorted, chancel arch at Tickencote, Rutland, c. 1180,

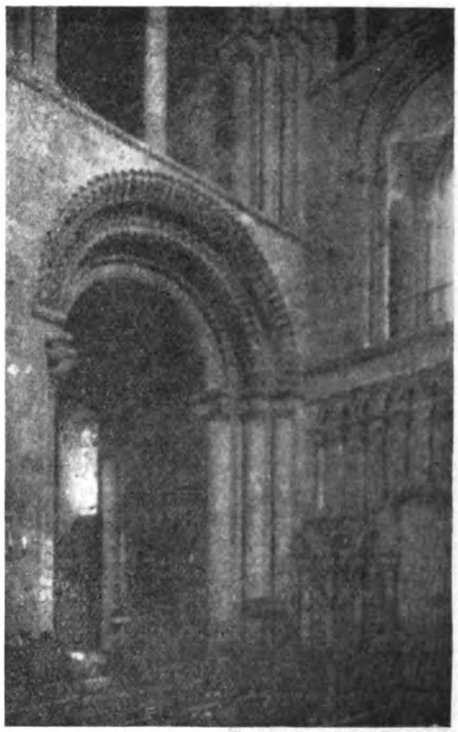

FIG. 3. Ely Cathedral: S.W. Transept.

and the late 12th century ceiling of the nave of Peterborough Cathedral shows a combination of architectural ornament with scrolled foliate patterns of more pictorial character, to which I shall return later. (Fig. 5).

The Prior's door at Ely, c. 1140, besides acanthus, has a running leaf pattern, and traces of interlacing; the south door at Romsey, c. 1160, has the acanthus and other more strictly architectural ornament, while the doorway in Durham Castle, built by Bishop Pudsey, c. 1175, shows an assemblage of masonry patterns as sumptuous as anything in the country.

The progress in technical skill and refinement of detail becomes more and more evident, and although barbaric richness, like that at Kilpeck, shows

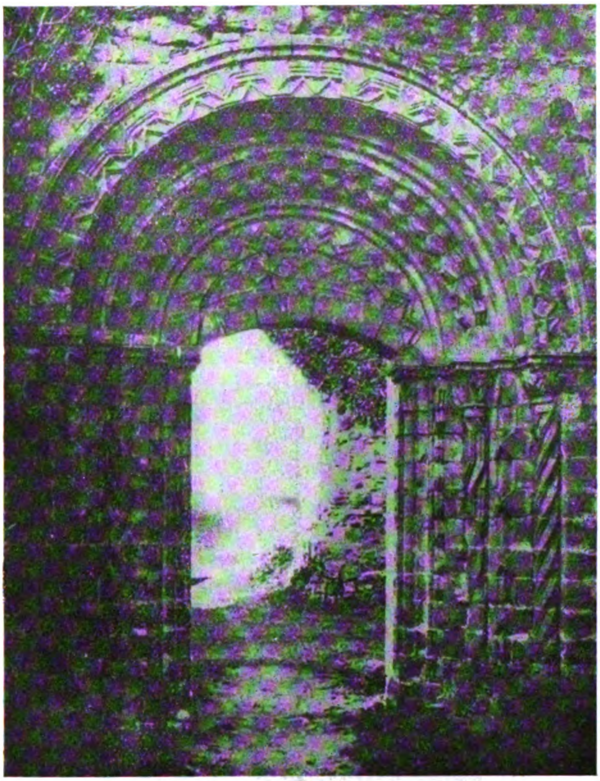

FIG. 4. Lilleshall Abbey: Cloister Door.

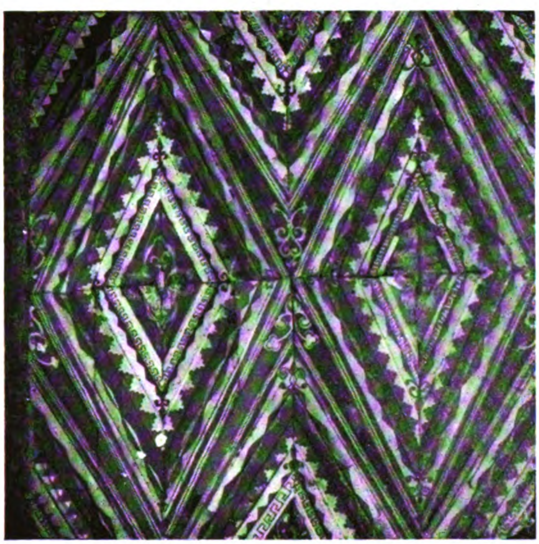

FIG. 5. Nave Ceiling, Peterborough Cathedral.

itself, the Northern stiffness and archaism become less and less apparent.

Patrixbourne and Barfreston in Kent have their elaborate ornament perfectly in control, and full of beautiful lines, while the simplicity and restraint of Compton chancel arch, Surrey, is a witness to the now entire mastery of material.

On the border line stands the Lady Chapel of Glastonbury, 1184-5, where the Romanesque is seen in its extreme transition, and from now onwards the whole range of leaf ornament seems to find itself and grow spontaneously to its consummation.

First the bud, as at Lincoln, 1200, and Wells, 1210, then the cluster, Wells, 1220, and Lincoln, 1225; then the expanded leaf, West Walton, 1230, (Fig. 6), Hexham, 1230, Bridlington, 1250, York, 1260, Durham, 1275.

FIG. 6. Capital from West Walton, Norfolk.

The spandril carvings at Wells, 1210, and Stone, 1240, show the same advance to complete freedom.

In the same way there is a unity in the arch ornament, a blend of richness and simplicity, which is the mark of a living style which has found itself. As far as technical skill is concerned, nothing more remains to be achieved. The tradition which starts with the Carolingian revival of the classic acanthus has, after four-and-a-half-centuries, come to a pitch of excellence not indeed foreseen, but logically proceeding from the conventions under which it began.

And now comes the inevitable sequel. The skill of the carver is his undoing. He can turn his leaves and sprays as he pleases; no task is too

hard for him. And so he is tempted to vie with nature, a thing no man can do. His leaves shall be ivy leaves, thorn leaves, maple leaves, vine leaves. And he appears to succeed, and here at the end of the 13th century to reach the high-water mark of Gothic art. But here he finds himself at

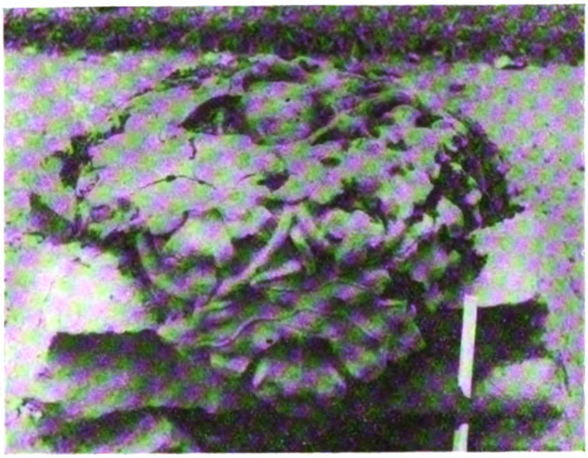

FIG. 7. Vaulting boss, Tintern Abbey.

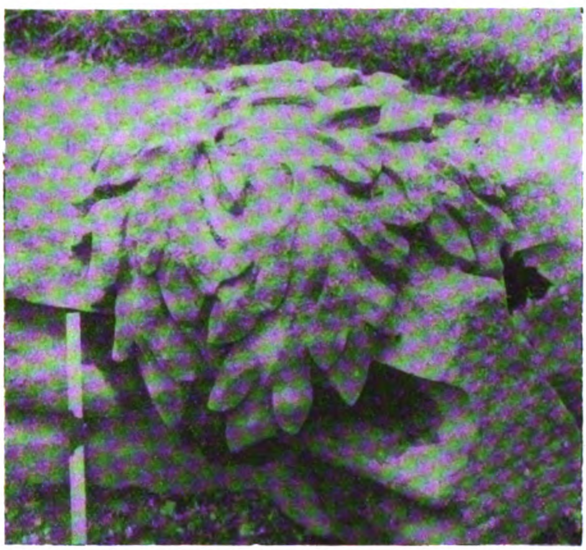

FIG. 8. Vaulting boss, Tintern Abbey.

the end of his tether; his material will go no further towards realism, and he perceives that he has, in fact, gone too far. So we may now see him turn back towards convention: but the old inspiration cannot be recalled.

He has lost his innocence, and where we saw freshness, we now see fussiness; skilful indeed, and in its details still, as ever, beautiful; but there is no room for doubt; the silver cord is loosed, and the golden bowl is broken. (Figs. 7, 8). It is only necessary to consider a series of examples dating from 1330 onwards, while the earlier work is still fresh in your minds. The ornament seems to lose heart, and architecture to have no further need of it and to rely more and more on its own forms. So the downward progress continues, with increasing loss of vitality and freshness, till the northern Gothic has said its last word and the revived classic forms begin to show themselves and to dominate the native style once more.

Here we see the cycle of history repeating itself—the northern barbarian has made history and has been master in his own house, but in the end he comes back for new inspiration to Rome.

So far I have spoken in terms of architecture, not because our record in the other arts is negligible in comparison. Far from it; but because it seemed more possible in this way to convey what seems to me to be the course and story of ornament in Britain. In painting, metal, embroidery, glass, earthenware, we have produced notable things, and the great decorative art of heraldry is a constant inspiration, having not only beauty, but a definite use to serve. This saves it from a certain tendency to archasim which undoubtedly affects the ornament of MSS., as may be seen by the comparison of a few examples of various dates. Thus, while the foliage in a late 12th century Psalter from Westminster Abbey is quite in keeping with the architectural carving of the time, allowing for the freedom of outline possible in a line drawing, a distinct tendency to archaism may be seen in the leaf-work of MSS. of the middle of the 13th century, and through all the realism of the next hundred years, a time when the English illuminators were at the height of their powers, reminiscences of the Carolingian conventions will occur, though they have long vanished from architectural decoration. The subject is one which deserves a fuller treatment than has yet been given to it.

CORRESPONDENCE.

REPORT ON THE SOCIETY'S EXAMINATIONS, 1926.

I should like to draw attention to a few points in the Report on the Society's Examinations. In former letters I have pointed out the fact that "bad spelling" (see page 1053 of the *Journal*) is caused by bad *pronunciation*, which again is due to the discrepancy between the written and spoken English language.

Complaints about the teaching of the two elementary subjects, handwriting and spelling, have been repeated for a quarter of a century (1900-1926), yet no examiner has discovered the cause or suggested a remedy. "Bad spelling is a sign of illiteracy," says one (3, page 1053), "and has to be punished severely." Illiteracy is due largely to want of time for reading, consequent on the necessity for "drilling

pupils rigorously " for their examinations (1) and the use in the schools of uninteresting text books instead of classical literature. The digraphs of the English language are very regular and should be recognised as phonetic *units*, instead of the vowel *letters* a, e, i, o, u, w, y, which have no international phonetic value. Bad spelling is due to bad printing. Bad spelling is *systematically taught* by the International Phonetic Alphabet in every College, University and Secondary School in the Empire, and will continue to torment the Examiners for another 25 years, unless a logical Arthotype Notation is adopted in educational books for all languages.

A. Deane Butcher.

ECONOMIC CONDITIONS IN SPAIN.

In an introductory note to his recent annual Report on the Industries and Commerce of Spain, the Commercial Secretary to H.M. Embassy at Madrid points out that the country is still passing through a period of transition, and, although in some respects economic conditions during 1925 and since have been more favourable, in others they have been distinctly less so than in 1924. While the wheat harvest has been exceptional, the mining industry has suffered from the universal trade depression. In spite of the general commercial crisis, Spain's foreign trade has expanded, and her industries have shown further development.

There is also no doubt—and this is perhaps of most importance to the British exporter—that the spirit of nationalism, which has taken hold of most nations in Europe since the war, has left its mark on Spanish trade with other nations. New barriers have been set up, and there are signs that the economic war is likely to become more bitter as time goes on. It is on this account, perhaps, that the United Kingdom, as a free trade country which has always been Spain's best customer, suffers most, as the time will come when extreme tariffs and vexatious restrictions to trade are too great an obstacle to be overcome, and the natural trade intercourse between the two countries will be seriously obstructed.

The country is capable of and undoubtedly needs great development, but progress must be slow until there is a general speeding-up of her administrative methods. In many respects the present Government, and the Military Directorate before them, have effected important reforms, such as the reorganisation of the Provincial Committees and the creation of new taxes to furnish them with resources of their own, but much has yet to be done.

The economic situation has improved, and the termination of hostilities should enable national activities to receive that share of the country's wealth which they so badly need.

STATE AID TO WATCHMAKING IN FRANCE.

The maintenance of schools giving technical instruction in watchmaking has long been a practice in both Switzerland and France. The oldest French institution of this sort is a municipal watchmaking school maintained at Besançon since 1861. According to a report by the United States Commercial Attaché in Paris, projects for State support of the watchmaking school have been under discussion for many years. They resulted in an agreement in 1921 between the city and the State by which the school was to be enlarged. Only in June, 1926, however, did this agreement take form in actual construction. The new buildings are to be on ground covering 9,300 square metres of a value of 6,500,000 francs. The new school is to be a national institution. In 1912 there were only 65 pupils attending the school. Now 170 are enrolled—all that can be accommodated in the space available. The new buildings are planned eventually to house 450 pupils.

CONTRIBUTIONS TO THE READING ROOM.

The Council acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and other Periodicals :—

TRANSACTIONS, ETC.

African Society, Journal.
American Academy of Arts and Sciences, Proceedings.
American Chemical Society, Journal.
American Institute of Electrical Engineers, Transactions.
American Leather Chemists' Association, Journal.
American Philosophical Society, Proceedings and Transactions.
Architectural Association, Journal.
Auctioneers' and Estate Agents' Institute, Journal.
Australasian Association for the Advancement of Science, Report.
Bath and West of England Society, Journal.
British Cold Storage and Ice Association, Proceedings.
British Dental Association, Journal.
Canada, Royal Society, Proceedings and Transactions.
Central Chamber of Agriculture, Journal.
Chartered Institute of Patent Agents, Transactions.
Chemical Society, Journal.
Chicago, Field Museum of Natural History, Publications.
Cleveland Institution of Engineers, Proceedings.
Commonwealth Institute of Science and Industry, Bulletin.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, La Revue Polytechnique.
Geological Society, Quarterly Journal.
Geologists' Association, Proceedings.
Glasgow, Royal Philosophical Society, Proceedings.
Imperial Arts League, Journal.
Imperial Institute, Bulletin.
India, Geological Survey, Memoirs and Palæontologia Indica.
Indian Meteorological Department, Monthly Weather Review.
Institute of Bankers, Journal.
Institute of Brewing, Journal.
Institute of British Carriage and Automobile Manufacturers, Journal.
Institute of Chemistry, Journal and Proceedings.
Institute of Metals, Journal.
Institute of Sanitary Engineers, Journal.
Institute of Transport, Journal.
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Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Electrical Engineers, Journal.
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Institution of Gas Engineers, Transactions.
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Institution of Naval Architects, Transactions.
Institution of Petroleum Technologists Journal.
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——————, Textile Institute, Journal.
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North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Norwich, Operative Brewers' Guild, Journal.
Nova Scotian Institute of Science, Transactions.
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Royal Society of Edinburgh, Transactions and Proceedings.
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Smithsonian Institution, Report and Publications.
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Society of Chemical Industry, Journal.
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Society of Engineers, Transactions.
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American Machinist.
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British Journal of Photography.
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Chamber of Commerce Journal.
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Fortnightly.

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Finance Chronicle.
Jeweller and Metalworker.
Perak Government Gazette.
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Revue Générale des Sciences.
West India Committee Circular.

Monthly.

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Automobile Engineer.
Bookseller.
Brewers' Journal.
British Builder.
British Engineers' Export Journal.
British Trade Journal.
Bulletin Technique du Bureau Veritas.
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Geographical Journal.
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Illuminating Engineer.
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Master Builder.
Mechanical Age.
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Daily Argosy (Demerara).
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Pioneer Mail (Allahabad).
South Africa.
Times of India (Overland Weekly Edition).

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 8.. Brewing, Institute of, at 39, Coventry Street, W.C. 7.45 p.m. Mr. W. J. Watkins "Some Notes on Enclosed Wort Refrigeration."

Electrical Engineers, Institution of, Savoy Place, Victoria Embankment, W.C. 7 p.m. Mr. D. J. Bolton, discussion on "The Economics of Lamp Choice."

At the University, Liverpool. 7 p.m. Mr. L. C. Grant, "High-Power Fusible Cut-outs."

At Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. S. Mavor "The Applications of Machinery at the Coal Face." Mr. L. Miller, "The Design of Storage-Battery Locomotives for use in Coal Mines." Mr. R. Nelson, "Electricity in Mines—a Short Survey."

Geographical Society, at Æolian Hall, 135, New Bond Street, W. 8.30 p.m. Mr. Roy Chapman Andrews, "The Work of the Central Asiatic Expedition in Mongolia." (Second "Asia" Lecture).

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Mr. George Mortimer, "Die-Casting."

Société Internationale de Philologie, Sciences et Beaux-Arts, 8, Taviton Street, W.C. 3.30 p.m. Mrs. Hylda Ball, "Some Poet Mystics."

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. D. Watney, Presidential Address.

Transport, Institute of, at the Queen's Hotel, Birmingham. 6 p.m. Major Frank Bustard, "Ocean Transport."

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Prince D. Svyatopolk Mirsky, "The Great Russian Poets." (Lecture V).

At King's College, Strand, W.C.2. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music." (Lecture III). 5.30 p.m. Dr. W. T. Gordon, Swiney Lecture. (Lecture II).

At University College, Gower Street, W.C.1. 5.30 p.m. Professor Dr. G. E. Moore, "Universals and Particulars." (Lecture I).

TUESDAY, NOVEMBER 9.. Asiatic Society, 74, Grosvenor Street, W. 4.30 p.m. Dr. C. Otto Blagden, "Indonesians and Indo-Chinese."

Electrical Engineers, Institute of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. W. L. Winning, Chairman's Address.

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. W. J. Guthrie, "Some Notes on Reduction Gear."

Mechanical Engineers, Institution of, at Swansea. Professor Frederic Bacon, Chairman's Address.

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Dr. F. M. Perkin, "Oil Fuels and other Fuels from carbonisation processes."

Quekett Microscopical Club, 11, Chandos Street, W. 7.30 p.m. Mr. A. A. Pearson, "Mushrooms and Toadstools."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. G. W. C. Kaye, "The Acoustics of Public Buildings." (Lecture II).

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture V).
At King's College, Strand, W.C.2. 5.30 p.m. Rev. Percy Dearmer, "Spanish Art." (Lecture V).
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5.15 p.m. "Accounting in Public Offices." (Lecture VI).

Wednesday, November 10..Arts, Royal Academy of, Burlington House, W. 4 p.m. Dr. A. P. Laurie, "The Theory of Colour and its Application to Painting." (Lecture I).

British Academy, Burlington House, W. 5 p.m. Prof. H. W. Carless Davis, "The Great Game in Central Asia." (Indian Frontier Politics, 1798-1844).

Central Asian Society, at the Royal Society of Arts, Adelphi, W.C. 5 p.m.

Electrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Messrs. J. R. Beard and T. G. N. Haldane, "The Design of City Distribution Systems and the Problem of Standardization."

Mechanical Engineers, Institution of, at the Mappin Hall, Sheffield. 7.30 p.m. Prof. Dr. E. G. Coker, "Elasticity and Plasticity." (Thomas Hawksley Lecture).

Wireless Technology, Institute of, at the Engineers' Club, Coventry Street, W. 7 p.m. Mr. A. H. A. C. Cranmer, "Automatic Transmission."

University of London, at the Institution of Electrical Engineers, Victoria Embankment, W.C.2. 5.30 p.m. Professor Dr. J. A. Fleming, "The Interaction of Pure Scientific Research and Electrical Engineering Practice." (Lecture V).
At King's College, Strand, W.C.2. 5.30 p.m. Dr. H. G. Atkins, "The Chivalry of Germany."
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 6 p.m. "Office Machinery." (Lecture VI).
At University College, Gower Street, W.C.1. 5 p.m. Dr. C. H. Best, "Insulin." (Lecture III).
5.30 p.m. Mr. I. C. Gröndahl, "Man and the World in Norwegian Poetry." (Lecture I).
5.30 p.m. Signor Camillo Pellizzi, "Dante e la Commedia nel giudizio dei contemporanei." (Lecture IV).

Thursday, November 11..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Electrical Engineers, Institution of, at University College, Dundee. 7.30 p.m. Prof. Dr. S. P. Smith "An All-Electric House."

Historical Society, 22, Russell Square, W.C. 5 p.m. Prof. Dr. W. T. Morgan, "Some Attempts at Imperial Co-operation in the Reign of Queen Anne."

L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. H. Cescinsky, "The Chippendale Style in England and America."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 7.30 p.m. Prof. Dr. E. G. Coker, "Elasticity and Plasticity." (Thomas Hawksley Lecture).

Oil and Colour Chemists' Association, at 8, St. Martin's Place, W.C. 8 p.m. Dr. J. J. Fox, "Cobalt Blue." "The Solubility of Paint Pigments."

Ophthalmic Opticians, Institute of, at the Royal Society of Arts, Adelphi, W.C. 8 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir Edgeworth David, "Antarctic Exploration." (Lecture II).

University of London, at the Imperial College of Science, South Kensington, S.W.7. 5.30 p.m. Major-Gen. Sir George Aston. Lecture on a Military Subject.
At King's College, Strand, W.C.2. 5 p.m. Dr. C. Da Fano, "Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System" (Lecture VI).
5 p.m. Dr. A. W. Pollard, "Bibliographical Evidence" (Lecture II).
5.30 p.m. Dr. Alexander Scott, "The Restoration and Preservation of Museum Objects."
5.30 p.m. Ifor L. Evans, "The Economic Organisation of the Danubian Lands: 1878-1914." (Lecture III).
5.30 p.m. Baron A. F. Meyendorff, "The Russian Church, Past and Present." (Lecture I).
At the London School of Economics, Houghton Street, Aldwych, W.C.2. 5.0 p.m. Professor G. Salvemini, "Economic Social and Political Life of the Italian Communes in the Thirteenth Century." (Lecture VI).
At University College, Gower Street, W.C.1. 4.15 p.m. Prof. F. Y. Eccles, "Bossuet." (Lecture V).
5.30 p.m. Prof. J. E. G. de Montmorency, "Legislative Tendencies in the English Speaking World." (Lecture IV).

Friday, November 12..Astronomical Society, Burlington House, W. 5 p.m.

Engineering Inspection, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.30 p.m. Mr. H. J. Davey, "Further Notes on Ciment Fondu."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Mr. L. J. T. Wheatley, "Estimating."
At Glasgow, Prof. Dr. E. G. Coker, "Elasticity and Plasticity." (Thomas Hawksley Lecture).

Metals, Institute of, at the University College, Singleton Park, Swansea. 7.15 p.m. Mr. J. H. Wells, "Zinc Smelting and Recovery of its Bye-Products."
At the University, St. George's Square, Sheffield. 7.30 p.m. Mr. H. Brearley, "Ingots and Ingot Making."

Société Internationale de Philologie, Sciences et Beaux-Arts, 8, Taviton Street, W.C.1. 8.15 p.m. Mr. F. G. Fraser, "The Post Office, Past and Present."

Philological Society, at University College, Gower Street, W.C. 8 p.m. Mr. Timothy Lewis, "Welsh Institutions."

Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m. (1) Mr. A. Dewhurst, "A Rapid Bolometer." (2) Dr. E. Griffiths and Mr. J. H. Awbery, "Hygrometry." (3) Prof. Smithells and Mr. Avery, "The Effect of Working on Tungsten."

Transport, Institute of, at the Town Hall, Newcastle-on-Tyne. 5 p.m. Mr. R. P. Lewis, "Divisional System of Railway Organisation."

University of London, at the Institute of Historical Research, Malet Street, W.C.1. 5.30 p.m. Dr. R. W. Seton-Watson, "Austria under Francis and Metternich." (Lecture IV).
At the Institution of Electrical Engineers, Victoria Embankment, W.C.2. 5.30 p.m. Professor Dr. J. A. Fleming, "The Interaction of Pure Scientific Research and Electrical Engineering Practice." (Lecture VI).
At King's College, Strand, W.C.2. 5.30 p.m. Dr. W. T. Gordon, Swiney Lecture. (Lecture III).
At University College, Gower Street, W.C.1. 5 p.m. Mr. R. K. Cannan, "Biological Oxidation-Reduction" (Lecture VI).
At Westfield College, Hampstead, N.W. 5.30 p.m. Dr. Ernest Barker, "Some Factors in the Formation of National Character." (Lecture II).

Saturday, November 13..L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. H. N. Milligan, "The Life of a Sea Urchin."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Rev. E. M. Walker, "The Study of History." (Lecture II).

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FUTURE OF ROAD TRANSPORT.

In delivering the 12th annual Thomas Hawkesley lecture at the Institution of Mechanical Engineers last week, Sir John A. F. Aspinall said every one was aware of the way in which railway traffic had been affected by the use of the modern motor vehicle. It seemed probable that the swelling volume of motor traffic would create its own blockade, and that certain classes of traffic which had been diverted from the railways to the roads would be recovered by the railways. The future congestion of the road system could be estimated by the fact that there were now about 1,250,000 licensed motor vehicles operating on a total road mileage in England, Scotland and Wales of 178,000 miles, which gave 6.98 machines to the mile. The rate of addition to the total stock of motors might be estimated at about 200,000 a year. If this continued for ten years the density of road traffic would be increased to 18 vehicles per mile if the traffic were equally distributed over the whole country. That would not be the case, and the congestion in and around the big cities threatened to be beyond the capacity of any traffic authority to handle. In making the above prediction, Sir John appears to have left out of account the development of road capacity. But if they do not prove Sir John's case the figures quoted serve to emphasise the importance of the progressive policy so ably advocated by Sir Henry Maybury. It is more than ever clear that every penny of the Road Fund will be needed for its legitimate purpose.—"*Contractors' Record,*" *Wednesday, November 11th,* 1925.

NEW METHODS OF HOUSE CONSTRUCTION.

In his presidential address, before the Institution of Structural Engineers last week, Sir Charles Ruthen, Director-General of Housing, said although anxious to avoid any statement that would stamp any particular new method of permanent house construction as superior to others, he was prepared to state that there were quite a number of concrete methods which almost entirely complied with the requirements. During the past 12 months or so no fewer than 20,000 houses of various new and alternative methods of construction had been erected in various parts of the country. This indicated that a serious effort had been made and was still being made to supplement the output of brick houses, and he felt confident that the experience gained would be of lasting benefit to national housing as well as to the ultimate benefit of all classes of building work, and all ranks of the building industry.—"*Contractors' Record, Wednesday, November 11th,* 1925.

Kindly mention the Society when communicating with Advertisers.

COLOURED CONCRETE HOUSES.

Lecturing recently on "London's Housing," at the L.C.C. School of Building, Mr. G. Topham Forrest, architect to the L.C.C., said :—

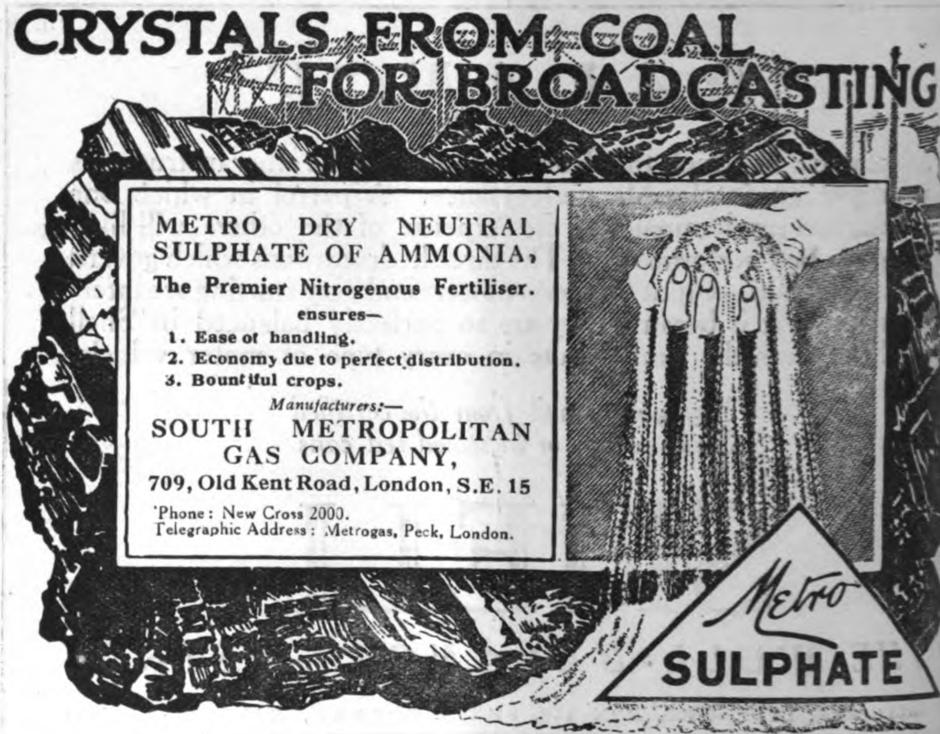
"In the future development of the L.C.C. housing estates, particularly Becontree, greater use will be made of concrete. In the past, objection has been raised to concrete houses on the ground that there is something very monotonous in a long series of dingy grey concrete houses. In America they have overcome this objection by the introduction of coloured material into the concrete and a similar method is to be adopted on the Council's estates.

"It is now possible to obtain Portland cement manufactured in various colours, and, in my opinion, it is practicable to introduce variety into the appearance of the roughcast houses by using these cements. Colours which approximate to those of red and stock bricks offer an opportunity for experiment which promises to be successful.

"White Portland cement is also procurable, and, by the intermixture of houses faced with white, buff, brown and red a quite agreeable effect can be obtained. Moreover, by this method, the cost of periodically re-colouring the external walls is avoided."

With regard to the reconstruction of insanitary areas, Mr. Topham Forrest described and illustrated some experimental blocks of tenement dwellings which it was proposed to erect. For these a special type of construction had been designed by which brickwork can be dispensed with. The construction consists of a light steel framework or skeleton, which will support floors of light steel and concrete extending to the outer faces of the structure. The enclosing walls will consist of concrete slabs with a finished weather-resisting outer surface.

He also described and illustrated nine-storey buildings suggested in connection with the reconstruction of an insanitary area in St. Pancras. The construction suggested is light steel framing; brickwork is to be limited to the external facings; and concrete panels are to be employed for the remainder of the walls and partitions.—*The Contractors' Record*, 25th November, 1925.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WEMBLEY SECRETS REVEALED.

The surprising revelation that the concrete terraces of the Stadium at Wembley, which have supported 150,000 persons at one time, are only one and a half inches thick was made by Mr. T. J. Clark, A.I.Struct.E., in a recent lecture.

Mr. Clark quoted as his authority Sir E. Owen Williams, K.B.E., the engineer responsible for the constructional work at the Exhibition, who, he said, had expressed the view that Wembley, though constructed purely as a temporary affair, might, so far as the concrete and steel edifices were concerned, quite well last for centuries.

"According to Sir Owen," said Mr. Clark, "the ideas of the public regarding Wembley's construction have probably been wide of the mark for the buildings are not so massive as is generally supposed. In the Palaces of Industry and Engineering the concrete in the outer walls, incredible as it may appear, is only two and a half inches in thickness; the buttresses, which appear so huge, are hollow.

"The layman who saw concrete floors bearing the weight of an L.M.S. engine, crowds of sightseers, and many stalls filled with goods, marvelled at its strength; but he will be astounded to learn that their thickness is only four inches."

Originally Sir Owen designed the floors to be five inches thick, but later found four inches sufficient. The eliminating of that inch over all the floors of the buildings in the Exhibition saved £25,000. On the floors of the Palace of Industry and Engineering alone £10,000 was saved.

"Sir Owen assured me, however, that the public need not be nervous of the thinness of the Stadium terraces, for the thin concrete on the steel piers would stand a weight four times as great as that of the heaviest crowd the Stadium will hold. People who watched the Tattoo and football cup finals were as safe as if they were on firm ground."

The Contractors' Record, December 16th, 1925.


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The Great Pyramid: its Divine Message.

By D. Davidson, M.C., M.Inst.Struct.E., and H. Aldersmith, M.B. (Lond.), F.R.C.S., (Williams and Norgate, 25s.)

This massive volume, containing nearly six hundred quarto pages, cannot be adequately described in the space usually allotted to a reviewer. It contains much controversial matter that cannot be touched upon at all in this journal, and much that can only be briefly alluded to. Written in a style that makes it comprehensible to a man of average education, it nevertheless deals with many recondite problems and questions, and its conclusions could be really tested only by a committee of savants and scientists.

The writer of the Introduction states "the work naturally divides itself into the following subjects: The History of Geometry and Metrology; Gravitational Astronomy; Astronomical Chronology; Archæology and History; and Theology." He might well have added to this list; for many of the problems dealt with in the book are of particular interest to the architect and engineer; some of them, indeed, could only have been solved by a practical builder, and the authors' treatment of these questions shows, in a most interesting manner, how the practical knowledge of the engineer and architect may be applied to the solution of archæological problems.

It has generally been assumed, and, indeed, stoutly upheld by many Egyptologists, that the sole purpose of the construction of the Great Pyramid was to afford a last resting place for the remains of the king under whose direction it was built. This theory, however, takes but little account of the complicated system of passages, galleries and chambers contained in the interior of the Pyramid, and the authors maintain that the embodiment of this system of passages and chambers was effected for a far more important purpose than that of providing a tomb for one of the kings of Egypt.

Needless to say, the idea that some ulterior purpose had dictated the construction of the Pyramid, is by no means original. It has endured in tradition and in ancient writings for thousands of years, and was revived among western savants during the latter half of the 18th century. Some of the readers of this journal will, no doubt, have heard of the researches and survey of Professor Piazzi Smyth, Astronomer-Royal for Scotland, undertaken in order to demonstrate that the Great Pyramid was a repository of ancient astronomical and geometrical science, and that the purpose of its construction was to convey a Divine Revelation to some future generation. This theory was combatted by Sir W. M. Flinders Petrie, the eminent Egyptologist, who made an extremely accurate survey of the exterior features of the Pyramid and its Passage System, and from his measurements demonstrated that the theories advanced by Piazzi Smyth and his school could not be corelated with the actual dimensions of the Great Pyramid.

The authors of the present work have accepted Petrie's survey as the most reliable hitherto undertaken, and claim to have demonstrated that Smyth's theory was actually correct, though on premises other than Smyth's and on premises other than Petrie's. Taking Petrie's linear measurements, and Smyth's angular measurements (on which Petrie could not improve), they reconstruct the Pyramid as it was before it suffered from the effects of dilapidation and subsidence, and from the dimensions of this reconstructed Pyramid, they draw their various inferences as to its astronomical, chronological and prophetical character.

It is well known that the Pyramid was originally covered with casing blocks of highly polished white limestone. and this fact, taken in conjunction with the orientation of the Pyramid, its latitude, and its face slope, gives rise to the hypothesis that one of the minor functions of the edifice was to act as the gnomon of a gigantic sundial, not, indeed, a sundial to mark the hours, but a sundial of the seasons. For it is demonstrated, by means of many diagrams, that the rays of the sun, falling from a

varying altitude at the different seasons of the year, upon the polished faces of the Pyramid, caused various differing shadows and reflexions, the form and direction of which announced the various seasons of sowing, harvest and inundation. The fact that the Pyramid is situated at the centre of a quadrant which embraces the whole of the Delta (the area of cultivation) and that its ancient name, *Khuti*, is translated by modern Egyptologists as "The Lights," are claimed by the authors as confirmation of this hypothesis.

The authors deal, in an exhaustive manner, with the ancient science of Metrology, and show that all ancient systems and units of measurement were dependent upon an original inch, which they name the Primitive or Pyramid Inch. This Primitive Inch, equal to 1.0011 British inches, is a unit of the Earth's Polar Diameter, and was the unit of measurement employed in the construction of the Great Pyramid. Investigation of the famous circle at Stonehenge discloses the fact that this unit was also employed in the construction of this monument, the deduction being that the megalithic builders, who have left traces of their work along the littoral of North Western Africa and South Western Europe, were of Oriental origin, and were responsible for the erection of the temple observatory at Stonehenge. This Primitive inch is also shown to be the original of our present British inch.

A secondary metrological system was also in existence, which appears to have been designed to avoid calculations involving the use of the ratio π, and to enable unskilled labour to carry out complicated constructional work by rule-of-thumb methods, a method somewhat analogous to that obtaining to-day in the operations of mass production in large engineering workshops.

(To be continued).

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The author's reconstruction of the original Pyramid affords many features of interest to the engineer. They demonstrate that the builders of the Pyramid were well aware that the rock foundation, upon which the Pyramid was built, was not stable, and that subsidence was bound to occur. At the same time, it was essential that the form and length of the internal passages and chambers should suffer the minimum distortion possible. This was effected by the peculiar chambers of construction in the mass of the Pyramid directly above the so-called King's Chamber, and the authors' demonstration that this method of construction was probably the only one that would counteract the subsidence effects that were to be anticipated, gives an idea of the remarkable skill and constructional knowledge possessed by the builders of this early epoch. An account of the method of construction of the Grand Gallery, nearly 30 feet in height, is given, showing how the lower courses were held true to line and distance, during the erection ot the heavy superstructure, by means of stone distance pieces, shouldered, housed and slotted into the side walls; how these distance pieces aided the work of construction, and how, when they were no longer necessary, they were cut off and slid down into the ascending passage, thus forming an additional seal against future entry.

The long descending passage, which passes deep into the natural rock below the foundation of the Pyramid, traverses some of the more important fissures in the rock, and, no doubt, served the purpose of the modern engineer's "trial-hole" or "trial-boring." It was from this descending passage that an upward tunnel was driven to the Grand Gallery, some time after the Pyramid was completed. There seems but little doubt that this was done for the purpose of inspecting the effects of subsidence, as a tunnel was also driven from the Grand Gallery to inspect the Chambers of Construction above the King's Chamber.

Allusion has already been made to the authors' theories as to the purpose of the Great Pyramid. That the ancient Egyptians held the same view with regard to the importance of the Pyramid's linear and surface measurements, and their relation to epochs of time, appears to be clearly demonstrated by an elaborate analysis of the King Lists. The summations of the regnal years of these lists are shown to represent various fiducial measurements of the Pyramid, to such a degree that the authors state that if the Great Pyramid were not now in existence, it could be reconstructed entirely from the dynastological lists of the Egyptians.

In the passage system of the Pyramid, the authors build up a geometrical framework embodying certain algebraic formulæ relating to various astronomical motions. The integration of these formulæ gives periods of time and chronological dates that are given by the ancient Egyptian texts, which were quite obscure before the integrations mentioned indicated their origin, and explained their relation to the subject matter of the text. The co-relation thus effected confirms the Coptic traditions relating to the Great Pyramid and its purpose.

The authors' researches have led them to conclude that, while it is possible for the modern man of science to resolve part of the riddle of the Pyramid, and

to reduce certain of its complicated expressions to their component parts, it would, nevertheless, be impossible for him to construct a solid geometrical expression of the various astronomical functions and chronological data that are contained in the structure of the Great Pyramid. Just as it requires but little knowledge and skill to dismantle a clock or watch, but much knowledge and skill to re-assemble it.

They consider, therefore that the designers of the Great Pyramid possessed knowledge and faculties that have since been lost; that they had a simpler and more effective method of ascertaining astronomical truths, and their inter-relations, than that possessed by modern astronomers.

The authors' final conclusions are to the effect that the Great Pyramid was built with the definite purpose of transmitting a message to some future civilisation able to interpret and understand the message; and that the various geometrical and astronomical features of its exterior were designed to direct attention to the interior where the message lay hid. Is it possible that half-forgotten memories of the true purpose of the Pyramid have given rise to the Masonic tradition of the pillar of Enoch?

DIAL PRESSURE GAUGES FOR LOW PRESSURES.

Of the indications required in modern industry, measurements of pressure are among the most frequent. Usually these are direct measurements of pressure of gas, air or steam in pipes, boilers or other containers. Sometimes, however, a pressure reading is required to indicate some other state such as, for instance, the level of liquid in a tank. For indicating pressures greater than some 10 lbs. per sq. in. dial gauges of the well known Bourdon tube type are almost invariably employed, but for lower pressures almost insurmountable difficulties have been experienced in applying the Bourdon tube principle on account of the very much greater sensitivity required in a low reading gauge, amounting to anything up to 2,000 or 3,000 times that of an ordinary pressure gauge reading up to say 100 lbs. per sq. in.

Two principal forms of gauges for low pressures are available, the liquid column pressure gauge and the dial pressure gauge. Dial gauges possess many valuable advantages over other types. Their indications are clearer and more convenient to read, and they require no attention, whereas tubes of liquid gauges become dirty and need frequent cleaning and refilling, an operation demanding a certain amount of skill. Dial gauges do not suffer from changes of zero, as do some liquid gauges, due to evaporation. They are less liable to damage in transit, easier to set up, and, if properly constructed, may be fitted up in any desired position and are not affected by such motions as the rolling or pitching of a ship.

All these advantages are possessed by the new gauge of the diaphragm type produced by Messrs. Negretti & Zambra. In designing this instrument special attention has been given to the peculiar requirements of low reading instruments, and ample control is provided, even when the pressures measured are equivalent to a head of water of only one or two inches. Pressure is led through a semi-flexible tube into two chambers which enclose sets of diaphragms. The pressure being applied to the outside of the diaphragms, these tend to collapse on themselves, and with an excess pressure, actually bed on one another. Over-stressing of the diaphragms is thus avoided, and no damage is sustained if they are subjected to an overload. The sets of diaphragms are built up from a number of thin discs of hard, non-corrosive, nickel-silver alloy, formed with a number of annular grooves or corrugations. The working range of each diaphragm is such that the elastic limit of the metal is never reached, or, indeed, approached, and the diaphragm itself is so formed that its total movement causes it to be dished in one direction at full pressure by approximately the same amount as it is in the opposite direction when under no pressure. Movement of the two sets of diaphragms is co-ordinated by a lever which has a spring fulcrum, and is operated by spring struts, without friction or backlash. A second spring strut is attached to one set of diaphragms and operates levers which magnify and transmit the motion of the diaphragms through a link to a balanced crank. A quadrant operates through the balanced crank gears with a pinion which carries the pointer. Both the quadrant and pointer are carefully balanced, and thus the whole mechanism is unaffected by alteration of position.

The control is very strong, and, notwithstanding the sensitivity of the gauge, is greatly in excess of that found in many high-pressure gauges. The crank has a large radius and the pinion is also large, having 24 teeth, as compared with the 8 or 10 usually found in such movements. This makes for increased accuracy and decreases the liability to undue wear.

A stop prevents the quadrant from coming out of mesh with the pinion at either end, and should excess pressure be applied no undue stress is imposed on this or any other part of the mechanism. Stops operate on each set of diaphragms should a suction be applied, and a slot at the top of the link permits the latter to continue its upward motion after the quadrant stop has come into operation, which is normally just before the movement of the diaphragms is arrested.

When the instrument is to be used as a depth gauge, it is advisable to fit it with a zero adjustment so that corrections due to small variations in installation may be made. The zero adjustment is effected by rotation and the whole of the mechanism, including the diaphragms within the case, by external milled screw. Because these gauges give a uniform pressure scale, this method of zero adjustment eliminates error through possible alteration of the range of the instrument, an error which is frequently experienced when the zero adjustment is effected by some movement of a part of the mechanism. As no stop is fitted to the pointer, it can be adjusted exactly to the zero scale mark.

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